THE PHILOSOPHY OF CHARACTER

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THE PHILOSOPHY OF CHARACTER

BY

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PREFACE

SOME years ago I determined to make a psychological study of character. James left the problem of the relation of purpose to bodily movements in a rather unsatisfactory state, and the psychology of the school of Münsterberg is still more unintelligible. Even Dr. McDougall's great contributions are in some respects unacceptable to me. Some statement involving different assumptions appeared to me necessary. The present work has therefore grown from the attempt to formulate the relation of purpose to the physical world, including the human body in the physical world. It is in a sense an introduction to a purposive psychology. That the results obtained are not wholly satisfactory it is needless to say; but to me some such statement as I have tried to outline is on the whole the most intelligible. I am firmly convinced that some point of view must be found which shall preserve for psychology the reality of purposive action and shall also give full value to the influence of bodily changes on the flow of our thoughts and in the determination of our acts.

In general I have tried to acknowledge my indebtedness to all authors whose ideas I have appropriated. In the scientific part of this book quotations are given, perhaps at too great length, where important scientific conclusions are involved. In the more philosophical part suggestions drawn from many sources have been freely used, sometimes without due recognition. To one philosopher, Mr. F. C. S. Schiller, I am very deeply indebted, but have made slight acknowledgment. Much of my opinion on the nature of reality is due to his writings, especially to his *Humanism* and *Studies in Humanism*. To the works of M. Henri Bergson I have made little explicit reference, but not

from lack of appreciation of their valuc. I am aware that I owe a great deal to the writings of M. Bergson, especially to his description of nature as a creative process; but with much that he has written, if I understand it, I cannot agree — for example, with his description of instinct and his account of the intellect.

To the many authors and publishers who have courteously allowed me to quote from their works I offer my sincere thanks. I am especially indebted to Miss A. F. Rowe for invaluable assistance in preparing the manuscript for the press, and to the Harvard University Press for its hearty coöperation.

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THE PHILOSOPHY OF CHARACTER

CHAPTER I

THE MEANING OF CHARACTER

CHARLES ELIOT NORTON once said that a chief characteristic of the American people is a stupid optimism. Some of us are optimistic enough to think that the United States has the chance to become the centre of the finest civilization the world has produced. This opportunity will be seized only if the characters of her citizens are equal to the task. The education and training, so largely moral and religious, of the Puritan family has vanished. This education, in spite of its limitation and narrowness and some hypocrisy, operating on responsive material, did produce strong and fine character and a firm belief in some theory of life. These firm beliefs and fine characters are now rarely to be found; surely they are owned by a relatively small number of persons. "We have been told by one of our most acute and attentive critics that humanity gives him the impression this earth is being used by the other planets as a lunatic asylum." [1] This cry has been heard in all ages, yet we do muddle along. But from the present turmoil and conflict of races and ideals, so characteristic of the times, something new will certainly arise.

If philosophy and psychology are more than mere pernicious pastimes, they must aid in the building of this new society, they must furnish the fundamentals for a sound theory of character, for on the development of character all else depends. This task has hardly been attempted. Philosophy is held to be remote from daily life; its teaching in our universities has too often re-

[1] H. M. Tomlinson, "England through English Eyes," in *Harper's Magazine*, July, 1922, p. 259. (Quoted by courtesy of Messrs. Harper and Brothers, New York and London.)

sulted in tearing down old ideals without furnishing a new light in their place, unless indeed such light is contained in the philosophy, only too prevalent, symbolized in the stanza of Kipling:

"As it will be in 'The Future,' it was at the birth of Man—
There are only four things certain since the Larger Primates began:
That the Dog returns to his Vomit and the Sow returns to her Mire,
And the burnt Fool's bandaged finger goes wabbling back to the fire." [1]

It is, of course, manifestly unfair to hold philosophy solely responsible for this result. Science bas contributed in no small measure, for orthodox science is essentially mechanistic. Moreover, science speaks with authority and sympathy, because it uses largely the same categories as common sense and because its practical results are so apparent and so easily verified. Yet, when all is said, it remains true that various forces have undermined our religious beliefs and given a great impetus to mechanistic ways of regarding life, and this in spite of such philosophers as William James. This weakening of old beliefs, accelerated of course by the influx of hosts of immigrants, has had a demoralizing effect on the character of our citizens which finds expression in the present degradation of municipal, state, and federal politics.

"Last Christmas eve, at a meeting of the college of cardinals, the venerable pontiff undertook to give an expression of the reasons which he believed were responsible for present conditions. The pope said there were five marks of unrest.

"The first . . . was the unprecedented challenge to authority.

"The second was the unprecedented hatred between man and man.

[1] Rudyard Kipling, "The Gods of the Copybook Maxims," in *Harper's Magazine*, January, 1920, p. 146. (Quoted by courtesy of the author, and of Messrs. A. P. Watt and Son, and Doubleday, Page, and Company.

"The third was an abnormal aversion to work.

"The fourth was marked by an excessive thirst for pleasure as the chief aim in life.

"The fifth he considered a gross materialism, which denied the reality of the spiritual in human life." [1]

Whether this is an authoritative report of the words of His Holiness I do not know; but it expresses much that I mean to imply.

Nor is this rather pessimistic view of modern society merely that of the impractical moralist. If you will read with some slight amount of care *Main Street* and *Babbitt* by Sinclair Lewis, *Certain People of Importance* by Kathleen Norris, *Cytherea* by Joseph Hergesheimer, *Lilian* by Arnold Bennett, *Simon called Peter* by Robert Keable, *Saint Teresa* by Henry Sydnor Harrison, *The Cathedral* by Hugh Walpole, and *The Research Magnificent* by H. G. Wells, you will become tolerably well acquainted with the morals and ideals of at least certain classes of the society in which we live. You will find some evidence of a disgust with this society, but you will find little or no suggestion of a remedy. You will find that our novelists have drawn a fairly accurate picture of modern life, a life built largely on prejudice, selfishness, vanity, ignorance, lust; full of material prosperity, but tragic, empty, without meaning, even sinister. It is a picture of a seething mass of humanity moved by primal impulses to feed, to rule, to propagate, disturbed by knowledge that these alone are insufficient for human needs, but not yet conscious of the ways and means to satisfy these needs; for conventional religion is shown to be insufficient, science is hopeless. It is a picture of a society with all its veneer of civilization but little removed from the life of beasts, without purpose, without conscious direction, without articulate ideal. Of course there are individual exceptions, and human nature is capable of more

[1] A letter to the *Springfield Republican*, reprinted by the *Boston Evening Transcript*, July 18, 1923. (By courtesy of the *Transcript*.)

than this. The story of the World War has shown what it will do when it believes. Is there nothing in which we may permanently believe and for which we may strive? Nothing worth while?

It may well be that life is not so hopeless and nasty as it appears, that human nature bas lost control of itself for the moment, has taken a wrong turn. It may be that, by the study of man, we may discover certain laws of behavior which, if applied to society, would banish some of the evils that beset us. It may be that, if we can understand character, we can see what kind of character leads to happiness and can gradually become united in a common purpose. Indeed, this is the main purpose of this book: to contribute to a theory of character which shall make possible a conscious social effort to develop the best character; more specifically, to show that character is individual purpose, — in its highest form self-conscious, rational, and unified, in its lowest form mere blind striving, — and that reality is the interaction of many characters, and is in a sense created and conditioned by the characters of the individuals which comprise it. The truth and value of science must be preserved, for science tells us all we know about reality; the mechanistic interpretations of science must apparently be superseded, thus preserving the ethical value of the individual and furnishing a foundation for religion conceived as respect, awe, and love for the universe in which we live and as an active desire to aid its development.

The aim of this book is, therefore, to contribute to the philosophic and scientific theory of character, with the purpose of furnishing a workable theory of life on which a psychology of character may be reared, which will in turn give a practical doctrine for the development of character — a task manifestly beyond my powers. Yet if one half the mental energy now devoted to the pursuit of useless wealth and power were turned in this direction, who can say what would be the result?

The chief proximate causes of this unfortunate fall from grace are the rapid spread of sceptical philosophic ideas brought about by philosophic criticism, by the mechanistic philosophy of science, by the general tendency to materialism resulting from the great industrial development of recent years, by reflection on orthodox religion forced upon many uncritical minds, especially by the stupendous misery of the World War. The remedy is to discover a rational theory of life which shall preserve the truth of science and yet emphasize the necessity of a moral and religious interpretation of experience, a theory in which intelligent people will believe and for which they will fight.

But it has been held that theory — philosophy — is the result, the attempted justification, of acts already performed, that it does not point the way but summarizes what is already accomplished; so theory is of no practical use. What actually happens appears to be something like this: Changed conditions, new knowledge, destroy old beliefs and force new adjustments. These attempts at new adjustments demand a new theory of life, which may be given by philosophy. This theory reacts again on beliefs and adjustments, suppressing some, supporting others. Theory and practice go hand in hand, the one reacting on the other; but practice can be consciously directed only by theory. If the mechanistic view of life is true, of course the belief that ideals or theories of conduct are efficacious in the processes of reality is an illusion. But since our study will, I hope, show that mechanism is probably inadequate, for the moment let us agree that theory may possibly have some real place in the world, and act on that assumption until we are shown to be wrong.[1]

[1] Cf. R. B. Perry, *Present Philosophical Tendencies*, 1912, pp. 1–23; L. T. Hobhouse, *The Rational Good*, 1921, pp. 3–76. For a general account of how opinion or theory is formed and how it works, see A. L. Lowell, *Public Opinion in War and Peace*, 1923; Graham Wallas, *Human Nature in Politics*, 1921, and *The Great Society*, 1921, especially Part II; W. E. Hocking, *The Meaning of God in Human Experience*, 1912, especially Part II, and *Morale and its Enemies*, 1918, Part I; William McDougall, *The Group Mind*, 1920.

In the use of words misunderstandings often occur, and these rather than real differences give rise to the majority of conflicts. It is therefore wise to attempt to explain in a general way what one is going to write about, to state the point of view from which the subject is to be approached. First of all, then, let us indicate roughly what is meant by character, and let us begin by reading some passages from Thomas à Kempis, from Emerson, and from Carlyle, because the somewhat figurative but beautiful sentences contain a whole lot of truth:

"Surely great words do not make a man holy and just; but a virtuous life maketh him dear to God.

"I had rather FEEL compunction, than know the definition thereof." [1]

"My son, thou oughtest with all diligence to endeavour, that, in every place and action, and in all outward business, thou be inwardly free, and thoroughly master of thyself; and that all things be under thee, and not thou under them." [2]

"The reason why we feel one man's presence and do not feel another's is as simple as gravity. Truth is the summit of being; justice is the application of it to affairs. All individual natures stand in a scale, according to the purity of this element in them. The will of the pure runs down from them into other natures, as water runs down from a higher into a lower vessel. This natural force is no more to be withstood than any other natural force. We can drive a stone upward for a moment into the air, but it is yet true that all stones will forever fall; and whatever instances can be quoted of unpunished theft, or of a lie which somebody credited, justice must prevail, and it is the privilege of truth to make itself believed. Character is this moral order seen through the medium of an individual nature. An individual is an

[1] Thomas à Kempis, *The Imitation of Christ*, book i, ch. i, § 3. (By courtesy of Messrs Thomas Nelson and Sons, New York.)
[2] *Ibid.*, book iii, ch. xxxviii, § 1.

encloser. Time and space, liberty and necessity, truth and thought, are left at large no longer. Now, the universe is a close or pound. All things exist in the man tinged with the manners of his soul." [1]

"I knew an amiable and accomplished person who undertook a practical reform, yet I was never able to find in him the enterprise of love he took in hand. He adopted it by ear and by the understanding from the books he had been reading. All his action was tentative, a piece of the city carried out into the fields, and was the city still, and no new fact, and could not inspire enthusiasm. Had there been something latent in the man, a terrible undemonstrated genius agitating and embarrassing his demeanor, we had watched for its advent. It is not enough that the intellect should see the evils and their remedy. We shall still postpone our existence, nor take the ground to which we are entitled, whilst it is only a thought and not a spirit that incites us." [2]

"Character repudiates intellect, yet excites it; and character passes into thought, is published so, and then is ashamed before new flashes of moral worth.

"Character is nature in the highest form. It is of no use to ape it or to contend with it. Somewhat is possible of resistance, and of persistence, and of creation, to this power, which will foil all emulation." [3]

"Two persons lately, very young children of the most high God, have given me occasion for thought. When I explored the source of their sanctity and charm for the imagination, it seemed as if each answered, 'From my nonconformity; I never listened to your people's law, or to what they call their gospel, and wasted my time. I was content with the simple rural poverty of

[1] Ralph Waldo Emerson, "Character," in *Essays*, 2d series, Riverside ed., 1888, pp. 94-95. (By courtesy of Houghton Mifflin Company, Boston.)
[2] *Ibid.*, pp. 100-101. [3] *Ibid.*, pp. 103-104.

my own; hence this sweetness; my work never reminds you of that; — is pure of that.' And nature advertises me in such persons that in democratic America she will not be democratized." [1]

So much for what character is. Let Carlyle tell us what character does:

"We have undertaken to discourse here for a little on Great Men, their manner of appearance in our world's business, how they have shaped themselves in the world's history, what ideas men formed of them, what work they did;—on Heroes, namely, and on their reception and performance; what I call Hero-worship and the Heroic in human affairs. Too evidently this is a large topic; deserving quite another treatment than we can expect to give it at present. A large topic; indeed, an illimitable one; wide as Universal History itself. For, as I take it, Universal History, the history of what man has accomplished in this world, is at bottom the History of the Great Men who have worked here. They were the leaders of men, these great ones; the modellers, patterns, and in a wide sense creators, of whatsoever the general mass of men contrived to do or to attain; all things that we see standing accomplished in the world are properly the outer material result, the practical realisation and embodiment, of Thoughts that dwelt in the Great Men sent into the world: the soul of the whole world's history, it may justly be considered, were the history of these. Too clearly it is a topic we shall do no justice to in this place!" [2]

And a passage in his *Characteristics* tells us how Heroes accomplish their ends:

"What sound mind among the French, for example, now fancies that men can be governed by 'Constitutions;' by the never so cunning mechanising of Self-interests, and all conceivable adjustments of checking and balancing; in a word, by the

[1] Emerson, "Character," p. 104.
[2] Thomas Carlyle, *Heroes and Hero-worship* (*Works*, Ashburton ed., iii, 1.)

best possible solution of this quite insoluble and impossible problem, *Given a world of Knaves, to produce an Honesty from their united actions?* . . . It is not by Mechanism, but by Religion; not by Self-interest, but by Loyalty, that men are governed or governable. . . .

"Here on Earth we are as Soldiers, fighting in a foreign land; that understand not the plan of campaign, and have no need to understand it; seeing well what is at our hand to be done. Let us do it like Soldiers; with submission, with courage, with a heroic joy. 'Whatsoever thy hand findeth to do, do it with all thy might.' Behind us, behind each one of us, lie Six Thousand Years of human effort, human conquest: before us is the boundless Time, with its yet uncreated and unconquered Continents and Eldorados, which we, even we, have to conquer, to create; and from the bosom of Eternity there shine for us celestial guiding stars.

> " 'My inheritance how wide and fair!
> Time is my fair seed-field, of Time I 'm heir.' "[1]

These passages, I believe, contain the elements of a theory of character. Let me re-state the doctrine in my own words, with such additions as I deem necessary.

Character as applied to persons is the unified sum of all the elements of personality, intellectual, emotional, instinctive.[2] It

[1] Carlyle, *Characteristics* (*Works*, xvi, 225–227). (These two passages from Carlyle are quoted by permission of Messrs. Chapman and Hall, Ltd., London.)

[2] This use of the word character is possibly broader than general custom sanctions. It seems, however, unwise to separate "intellect" too completely from the active side of human nature, especially in a preliminary definition. Cf. John Stuart Mill, *A System of Logic*, book vi, ch. iv, "Of the Laws of Mind"; book vi, ch. v, "Of Ethology, or the Science of the Formation of Character." Mill's account is summarized in *The Ethics of John Stuart Mill*, by Charles [M.] Douglas, 1897, especially ch. v. See also William McDougall, *Outline of Psychology*, 1923, p. 417, and *The Group Mind*, 1920, p. 101; James Ward, *Psychological Principles*, 1918, pp. 453–461; R. O. Filter, "A Practical Definition of Character," in *Psychological Review*, 1922, xxix, 319–324.

is the agglomeration of all knowledge, whether innate or acquired during the history of the individual, together with his reactions, emotional, instinctive, teleological, and non-teleological, whether inherited or acquired, to such knowledge.

Character and personality thus become one and the same. But ordinarily we speak of a person as having character. Character is the sum of the attributes of the person. There is some entity that possesses the attributes, just as an object is regarded as possessing hardness as an attribute. Whether character implies more than the unified sum of the elements that make up character, whether it implies something that owns these elements, as a soul, is a question which we leave open without prejudice.

Character, then, is not mere knowledge; it is a compelling belief in certain knowledge which forces action, and thus, taken with environment, determines the conduct of individuals. Thomas à Kempis said he would rather feel compunction than know the definition thereof, and with this I suppose Emerson would agree. Character is not mere intellect, it is something more; it is striving for an end. Conduct is determined not only by the intellectually perceived end, but by the attitude of the individual toward that end.

Examples of what I mean will occur to all. In our universities we occasionally find a man of the most brilliant mind who pursues his subject not for the sake of truth but for his personal advancement, who at times cares more for writing an original article or for reporting the result of an experiment than he cares for the truth contained. In mercantile and professional occupations we find individuals of great ability who put financial return before personal honesty, and oftentimes such men apparently succeed. Fortunately, however, such are not in the long run the directing majority; for all social life, all business life, depends on the good character, the general reliability and honesty,

of the various individuals that compose it. Even in such a practical publication as *Bradstreet's*, which gives the ratings of business concerns, the amount or grade of credit to which a person is entitled is given in part in terms of character; so that one with property of $500,000 may be graded as "A," the highest for that class; another with the same amount of property may be graded as "E," which would mean that he was unreliable. In the professional world some lawyers are recognized as above all mere mercenary considerations in their dealings with their clients; others are under the suspicion of taking a case for their own personal gain without regard to the interests of those whom they are supposed to serve. Some in the medical profession prostitute their good name for money; even some clergymen seem not so much interested in preaching the word of God as in filling their churches. Some scientists prefer to use their talents for the amassing of wealth, others give their lives to research with no desire for material reward. Some painters, inspired by the most precious emotions, produce ideal representations of life; others give us pictures perhaps equally excellent in a narrow technical sense but inspired by what seems merely nastiness of mind; even among philosophers, *I suppose, examples of all these* weaknesses may be found. Some musicians give us an audible expression of our highest and noblest aspirations; others mak their appeal to our animal instincts, often of sex, as I believe be true of most of Wagner's music. Some scientists and philo phers give us a materialistic, some an idealistic, one a monad a another a pluralistic, account of the world in which we live. Everywhere the character of the individual determines which way he will jump.

In all these examples it appears that knowledge, intellectual attainments, technical and business ability, artistic and philosophic skill, while necessary instruments, are in truth mere instruments; that something uses these instruments for more or

less definite ends, and that a more or less clearly defined judgment is made as to the value of these ends — an ethical judgment is involved.

The dishonest business man decides that life for him is amassing wealth by any means in his power. Not that he necessarily reasons this out and explicitly adopts such a theory of life, but a combination of impulses, desires, theories, observations of life, leads him to perform certain acts. When he performs them he believes that they are good for him at that particular time, whatever he may think afterwards. Nay, often action apparently ensues, without any explicit decision, from mere instinctive or habitual impulse; then one may wake up, as it were, and say, "Why did I do that?" But the act is then approved or rejected; we are either glad or sorry.

What uses these instruments and makes these judgments has been given many names and has been described in many fashions. For the present let us agree that the agent is the personality, having a definite individual character; let us leave open for the present any theory as to what this personality is, whether brain cells, transcendental ego, soul, or what not. If you will once agree to this, then the study of character becomes the most interesting and vital of all pursuits, because *all* human activity is determined by the characters of the various individuals that compose society.

One does not like to live intellectually alone. This opinion that the study of character, of the springs of conduct, of human nature, furnishes the sole adequate foundation for the social sciences, is now beginning to be recognized. Thus Mr. H. G. Wells says: "How are we to secure the best direction of human affairs and the maximum of willing coöperation with that direction? This is ultimately a complex problem in psychology, but it is absurd to pretend that it is an insoluble one." [1] And Mr.

[1] Wells, *The Outline of History*, 1921, ii, 418. (Quoted by courtesy of The Macmillan Company, New York.)

Graham Wallas: "In the great university whose constituent colleges are the universities of the world, there is a steadily growing body of professors and students of politics who give the whole day to their work. I cannot but think that as years go on, more of them will call to their aid that study of mankind which is the ancient ally of the moral sciences." [1]

Dr. William McDougall has long supported some such view: "Among students of the social sciences there has always been a certain number who have recognized the fact that some knowledge of the human mind and of its modes of operation is an essential part of their equipment, and that the successful development of the social sciences must be dependent upon the fulness and accuracy of such knowledge. . . . There are signs . . . that psychology will before long be accorded in universal practice the position at the base of the social sciences which the more clear-sighted have long seen that it ought to occupy." [2]

Dr. Z. C. Dickinson clearly recognizes that many of the problems in economics are those of the response of the human organism to special stimuli, which is clearly the problem of character.[3] Thus to-day characters that want automobiles determine what form industry shall now take; in the twelfth and thirteenth centuries characters that demanded Gothic cathedrals determined in part the industrial activity of that period.

James Martineau says, "Ethics may be briefly defined as the doctrine of human character." [4]

Especially Dr. John Dewey emphasizes our point: "And a trained imagination may discover that the nationalistic and

[1] Wallas, *Human Nature in Politics*, 3d ed., 1921, p. 41. (By courtesy of Messrs. Constable and Company, Ltd., London, and A. A. Knopf, Inc., New York.)

[2] McDougall, *An Introduction to Social Psychology*, 13th ed., 1918, pp. 1–2 (by courtesy of John W. Luce and Company, Boston). See also Lothrop Stoddard, *The Revolt against Civilization*, 1922, especially pp. 8–11.

[3] Dickinson, *Economic Motives*, 1922, especially pp. 1–15.

[4] Martineau, *Types of Ethical Theory*, 3d ed., 1891, p. 1. (By courtesy of the delegates of the Clarendon Press, Oxford.)

economic wars which are the chief outward mark of the present are in the end to be less significant than the development of a science of human nature now inchoate." [1]

From all this it seems clear that the study of character is of great practical importance. Also it is evident that the word character implies some judgment of value, some appraisal of the worth of the individual. These judgments of the value of character are roughly of two kinds, which may figuratively be called quantitative and qualitative. Characters are weak or strong, good or bad.

An imbecile at the mercy of every impulse and stimulus has some kind of character, but not of the same grade as a Napoleon, whose behavior is unified by a ruling passion. Most of us in ordinary circumstances are, like imbeciles, torn by conflicting purposes; but in time of war a great passion seizes us, all minor purposes disappear, we are conscious of unified purpose, of character, accompanied by happiness and a disappearance of conflict. Unity of organization is, then, essential to character. But this unity may extend from the mere recognition that various impulses are mine, not yours, to a relatively complete union of knowledge and purpose into a unified whole, a complete character. If this unification is accompanied by force, by activity, by intense conviction, then the character is recognized as strong. Unity and force are apparently the quantitative aspects of character.

But even this is not enough, for this unified character is judged as either good or bad. My passionate devotion to a cause may be from an evil or from a good will, and a good will may be misdirected. A true estimate of character involves a knowledge of the goal for which one should strive. Since it is impossible to hold — provided there is really such a thing as ethics — that such a goal is a temporary affair which we may

[1] Dewey, *Human Nature and Conduct*, 1922, p. 323. (By courtesy of Messrs. Henry Holt and Company, New York.)

imperfectly attain but which is doomed some time to perish into nothingness, such an ideal involves the assumption that the goal of endeavor as expressed in a good character is an eternal goal.[1] If what we do is to perish utterly, then ethics and religion are shams. The individual character must be in some way a "close or pound" in which the eternal is caught, so that "all things exist in the man tinged with the manners of his soul."

But how shall we recognize such a man? What is the goal which makes even a strong, unified character really valuable? What is the aim of life? Thus our judgment of the qualitative worth of a character involves all knowledge, and we cannot hope to solve all its problems. We may perhaps reach some rough, vague working hypothesis, but a complete theory of character includes some determination of the nature of the "Good."

If character, or the person, is a moral agent, then not only must it be in some sense eternal but it must be inwardly free. If my conduct is determined wholly by physical causes, then praise or blame, endeavor, ethical conduct, disappear; these terms become vain words. If we are inwardly free, action must be determined, at least partly, by our inner nature, which must be conceived, in spiritual or mental terms, as purpose. As no ethical conduct can be conceived which does not involve more than my individual self, then reality must be a plurality of individual characters, which we recognize as being of different degrees of worth. By inspiring loyalty great characters determine the course of history, not because they are essentially different from ordinary characters but because they embody what is implicit in their age. Thus the example of Jesus overflows from him, the higher, into us, the lower vessels.

Character, then, is the more or less unified mass of all the elements of personality. It implies that a person is a moral agent,

[1] See Josiah Royce, *The Philosophy of Loyalty*, 1908; W. E. Hocking, *The Meaning of God in Human Experience*, 1912, especially chs. viii and ix.

and thus free from outward compulsion, whose acts are of eternal worth. Such a moral agent implies finite, real minds. Therefore character as an active force in the world assumes real, spiritual individuals, who act, in so far as they are free, from inner determination, not by physical compulsion. The very essence of our idea of moral agents involves such real, free, finite individuals.

Character as thus defined can be stated only in terms of an idealistic philosophy, a philosophy which holds that reality is mental; but such philosophy must preserve the reality of the individual,[1] it must be a pluralistic, objective idealism. This means that our universe becomes a community of individual minds related to each other as the parts of an organism are related, forming a whole composed of parts. The world of science, the material world, is a partial statement of the activity of these individuals that are of different orders; it exists only as the activity of mind. The laws and descriptions of science preserve whatever validity they may possess; only the metaphysical theory of matter is inadequate. The world is a mental world; its institutions, morals, — nay, what we call inert matter, — are all manifestations of mind. The study of character is the study of the activity that produces our universe; an insight into the meaning of mental activity, and into the means of controlling and directing it, is the vital object of science. Thus human history becomes an account of the unfolding of human character or, as Hegel imperfectly put it, of the Idea; imperfect because history, while in a sense the story of the development of ideas, yet is the narrative of ideas held by individuals in a changing environment, not the unfolding of an absolute idea. The economic theory of history is only partly true because it attributes the course of history wholly to economic environment, whereas

[1] A. G. Heath, *The Moral and Social Significance of the Conception of Personality* 1921.

environment is only one element in the development of character. For Dr. William McDougall history appears to be the unfolding not of ideas but of innate instinct-like tendencies; and again innate character is over-emphasized in relation to environment and conscious purpose. They all fail in not recognizing the mysterious activity of the individual, which must be free in the sense that it results from inward, not outward, determination; otherwise all endeavor is sham.[1] So cosmic history becomes the development of the character, or characters, which are reality; and the study of evolution is the description of the way these characters actually do develop.

To furnish a complete theory of character would, then, involve all branches of knowledge. Our aim is much more modest, but is sufficiently difficult. It is to discover a philosophic basis for a scientific psychology of character which will preserve the validity of scientific law and the moral value of life.

[1] I think that Dr. McDougall recognizes the necessity of moral freedom, but it is not clear to me how he incorporates it in his description of human conduct. The sense in which "inward determination" is used will appear in the course of our discussion.

CHAPTER II

SCIENCE AND PHILOSOPHY

It is apparent that I am going to base my theory of the science of character on a metaphysical theory of reality, on a kind of pluralistic idealism. Many will say that the assumption of a metaphysical theory as the basis for a scientific study vitiates the scientific results. I make no apology for introducing philosophic criticism into the study of science, for all science makes some metaphysical assumptions, is based on some kind of philosophic theory of reality. Indeed, common sense, every act of our daily life, depends on some such assumptions. I prefer to make these assumptions, if such they are, consciously and with as much searching criticism as my capacities allow, rather than unwittingly to make them and subsequently to scoff at metaphysics. I do not wish to be understood to hold that science in a certain sense cannot exist without metaphysics, for of course in so far as it merely states empirical laws it can so exist. But when it attempts to formulate any general statement of reality, either implicitly or explicitly, then it rests on philosophy. A science of character based on psychology is so bound up with fundamental problems that to my mind it is dangerous, if not impossible, to formulate such a science without some perception of the metaphysical problems involved. I do not wish to assert that a psychology of character should be deduced from a philosophy, but I do hold that the facts of a science of psychology can be interpreted in the light of a suitable philosophy so as to preserve both the validity of the observed facts and laws and the moral value of life.

Before an intelligible scientific psychology of character is possible, much preliminary work must be endured, and for this reason: the philosophical theories held by all writers on psychol-

ogy, which is usually classed as a science, and in fact by writers on all scientific subjects, influence and determine, perhaps prejudice, the general theoretical view of the science involved; and this is true whether the philosophical theory is explicitly present or not. We shall therefore have to examine in a summary way some concepts of science and attempt to formulate a theory which shall preserve the value of scientific truth while attempting to avoid the difficulties that inhere in many views of science. Let us then begin with an attempt to define the science of psychology. This is not an easy task; for, as Münsterberg well says, "to reach a clear understanding as to the true meaning of psychology is a more difficult task than the solution of any special psychological problem." [1]

According to William James, "Psychology is the Science of Mental Life, both of its phenomena and their conditions." [2] With this definition Münsterberg, Titchener, Baldwin, Ward, Wundt, McDougall, Rehmke, Robinson, and a host of others would not seriously quarrel,[3] surely not in so far as psychology is held in some manner to deal with mental phenomena, with mind. But there has grown up in recent years a school, the "Behaviorist," which denies the propriety of including mental states, conscious phenomena, mental life, in the study of psychology. One of the most prominent exponents of this doctrine is Dr. John B. Watson:

[1] Hugo Münsterberg, *Psychology, General and Applied*, 1914, p. 8. (Quoted by courtesy of Messrs. D. Appleton and Company, New York.)

[2] James, *The Principles of Psychology*, 1890, i, 1. (Quotations are by courtesy of Messrs. Henry Holt and Company, New York.)

[3] Münsterberg, *Psychology, General and Applied*, pp. 1–58; E. B. Titchener, *An Outline of Psychology*, 1897, pp. 3–6; James Mark Baldwin, *Handbook of Psychology*, 2d ed., 1890, pp. 1–8; James Ward, *Psychological Principles*, 1918, pp. 1–28; Wilhelm Wundt, *Grundzüge der Physiologischen Psychologie*, 4th ed., 1893, i, 1–6; William McDougall, *An Introduction to Social Psychology*, 1918, p. 15, and *Outline of Psychology*, 1923, pp. 1–39; Johanaes Rehmke, *Lehrbuch der Allgemeinen Psychologie*, 1894, pp. 1–13; Arthur Robinson, "Behaviour as a Psychological Concept," Aristotelian Society, *Proceedings*, 1917–18, p. 285.

"For example, the reader will find no discussion of consciousness and no reference to such terms as sensation, perception, attention, will, image and the like. These terms are in good repute, but I have found that I can get along without them both in carrying out investigations and in presenting psychology as a system to my students. I frankly do not know what they mean, nor do I believe that any one else can use them consistently."[1] According to this view, a definition of our science would then be in some such terms as these:

"Psychology is that division of natural science which takes human activity and conduct as its subject-matter. It attempts to formulate through systematic observation and experimentation the laws and principles which underlie man's reactions. Every one agrees that man's acts are determined by something, and that, whether he acts orderly or not, there are sufficient grounds for his acting as he does act, if only these grounds can be discovered."[2]

"It is a serious misunderstanding of the behaviouristic position to say, as Mr. Thomson does — 'And of course a behaviourist does not deny that mental states exist. He merely prefers to ignore them.' He 'ignores' them in the same sense that chemistry ignores alchemy, astronomy horoscopy, and psychology telepathy and psychic manifestations. The behaviourist does not concern himself with them because as the stream of his science broadens and deepens such older concepts are sucked under, never to reappear."[3]

I have not seen any definite statement as to how Dr. Watson would interpret those phenomena which one ordinarily means when one says mental, but apparently "mental phenomena" do

not exist; all experience is some kind of material phenomena; all is to be interpreted in physical terms, and psychology becomes the study of the laws of the reaction of the body to various outward stimuli.

So at the very outset we have run against a snag, one authority defining psychology as the scientific study of conscious phenomena, the other as that of human and animal behavior excluding consciousness. As one of the methods of psychology there is no question of the value of this objective attitude, but apparently there are such phenomena in the world as pains, emotions, ideas. If mental states are to be excluded from scientific study it must be for one of the following reasons: either they cannot be defined, the words mean nothing, therefore they must be excluded; or they are not realities but are a manifestation of something else — matter. If I understand Dr. Watson aright, he makes both these assertions. Let us take the difficulty of definition first.

I look out of my window and see a tree. What do I mean by "tree"? "Mean" here, as with Watson, I think, signifies "define"; but "all definitions of terms are effected by means of other terms," and "every system of definitions which is not circular must start from a certain apparatus of undefined terms." [1] Thus the Century Dictionary defines tree as "a perennial plant which grows from the ground with a single permanent woody self-supporting trunk or stem, ordinarily to a height of at least 25 or 30 feet."

If in our example of the tree we try to carry our definition further and say what we mean by plant, we shall perhaps say that a plant is part of organic as opposed to inorganic nature. But when we try to define an organism exactly we shall begin to

[1] Bertrand Russell, "The Theory of Implication," in *American Journal of Mathematics*, 1906, xxviii, 160; quoted by Edwin B. Holt, *The Concept of Consciousness*, 1914, p. 4. (Requoted here by courtesy of The Macmillan Company, New York.)

meet with difficulties, and even more serious will these become when we try to tell what we mean by inorganic matter. The fundamental concepts are really undefinable in other terms. What we mean by such fundamental concepts can be made sufficiently clear by the process of exhibition,— by pointing out what we mean. Thus we may point to a stone and a tree and say the tree is an organism, the stone is not; and no one will fail to see that I mean a different kind of object in one case from what I do in the other. Just so it is pretty difficult to define either material or mental phenomena, but we can point out these different phenomena; we can mean different kinds of events, whatever their ultimate nature may be. So for the present I want to point to phenomena like the formation of water from oxygen and hydrogen, and to call this a material phenomenon; and also to phenomena like those that occur when I put my finger in a flame. This latter phenomenon must be observed by each one for himself, and the exhibition must be made by an appeal to introspection and subsequent testimony. Do you experience pain when your finger is put in a flame? If so, I can point out or exhibit what I mean by a mental phenomenon. So I think, as far as being intelligible and as far as definition go, I have a right to talk about mental states. Possibly, therefore, for a supplementary definition of psychology we may use that of Mr. Arthur Robinson: "Psychology . . . is the science of the conscious organism *quâ* conscious; it has to study the processes whereby such an organism becomes aware and acquires knowledge of its environment and responds thereto. Such parts of the total response as an onlooker can observe may be called behaviour, but behaviour is not the characteristic, still less the sole, category of psychology." [1]

But Dr. Watson apparently makes a more vital assertion —

[1] "Behaviour as a Psychological Concept," Aristotelian Society, *Proceedings*, 1917–18, p. 285. (By courtesy of Messrs. Williams and Norgate, London.)

that mental states are in reality material states, that psychical categories are reducible to material; and he is not alone in this view. Thus Laplace holds that "an intelligence which, for a given instant, should know all the forces by which nature is animated and the respective positions of the beings composing it, if further it was sufficiently vast to submit these data to analysis, would include in one formula the motions of the largest bodies in the universe and those of the lightest atom; nothing would be uncertain for it, and the future as well as the past would be present to its eyes." [1]

The problem of the relation of the mental to the physical was probably not in the mind of Laplace when he wrote this passage; but, if it is literally true, there is no place in the world for mental states; if they have any reality at all it is merely as spectators of events over which they have no control. There are at least some scientists who hold that all phenomena, all content of life, must be ultimately included in some general physico-chemical formula, some such formula as Laplace had in mind:

"It is the object of this paper to discuss the question whether our present knowledge gives us any hope that ultimately life, i.e., the sum of all life phenomena, can be unequivocally explained in physico-chemical terms." [2]

"Although we are not yet able to state how life originated in general, another, more modest problem, has been solved." [3] That is, unfertilized eggs have been caused to develop by chemical and mechanical stimulation.

"Nothing indicates, however, at present that the artificial production of living matter is beyond the possibilities of science." [4] But the theory that germs of life are forced through

[1] Laplace, *Théorie analytique des probabilités*, Introd (*Œuvres complètes*, vol vii, pp vi–vii), quoted also by James Ward, *Naturalism and Agnosticism*, 1899, i, 41, and by Bergson, *L'évolution créatrice*, 1907, p 41

[2] Jacques Loeb, *The Mechanistic Conception of Life*, 1912, p 8 (By courtesy of the University of Chicago Press, Chicago, Illinois)

[3] *Ibid*, p. 6 [4] *Ibid*, p 5

space to the earth by radiation must not, he says, be discarded. "But I believe that we must also follow out the other problem: namely, we must either succeed in producing living matter artificially, or we must find the reasons why this is impossible." [1]

"The contents of life from the cradle to the bier are wishes and hopes, efforts and struggles, and unfortunately also disappointments and suffering. And this inner life should be amenable to a physico-chemical analysis? In spite of the gulf which separates us today from such an aim I believe that it is attainable." [2]

And Max Verworn, of course holding that psychology is a branch of physiology, says this much is certain: There can never be for physiology any other principle of explanation than that which holds for physics and chemistry. The assumption of a special life-force is unnecessary and inadmissible because it rests on the fact that we have not pushed our analysis far enough.[3] With these *words* I can agree, but I think Verworn has not pushed his analysis far enough. When we do so we shall find that reality is mental, that the laws of nature are the laws of habit, fixed and permanent enough, yet for the future determined by individual endeavor; not indeterminate in the sense of chance, but determined by our inner nature, which has existed for all time and may exist indefinitely.

The mechanistic thesis is that the world of nature shows continuity, that the same kind of laws apply to thought as to physical things. Physical things are matter which exists independent of mind. We must, then, explain man both in body and in mind according to the same laws that we find operating in physical chemistry. If such a position is tenable, Laplace's dream is possible and Watson is presumably right. The implications of such a theory destroy the meaning of life, take away all possibility of

[1] Loeb, *Mechanistic Conception*, pp. 5–6. [2] *Ibid.*, p. 26.
[3] Verworn, *Allgemeine Physiologie*, 6th ed., 1915, p. 53.

human endeavor, make the study of character a part of physical chemistry, the evolution of the world and of mind merely a change in the arrangement of ultimate units of some sort according to necessary law — nay, perhaps exclude the possibility of change.

It would seem that any such attempt must fail, not essentially because of any limitation in human powers of observation and experiment but because the attempt is inherently impossible, just as it is inherently impossible to lift one's self by pulling at one's own boot-straps. Let us admit once for all that it is not impossible for chemists to produce living matter — yes, even that this living matter is also conscious in fundamentally the same way that we are conscious; yet even then I cannot see how any combination of molecules, atoms, or electrons can *be* a conscious state. The pain I have when my tooth aches is not to be conceived as a motion of molecules or atoms either to the right or to the left or as a spiral or as an increase or a decrease in activity. It is a pain, it is mental. Nor can pain be rightly conceived as something new, which arises as the result of a synthesis of material elements, as water results from the combination of oxygen and hydrogen. Here the combination does indeed produce new qualities, it can dissolve certain substances; but these new qualities are all describable in the same terms—motions of molecules or of atoms — as are the parts forming the combination. Not so with pain; this is a primal fact not describable in such terms. If life and consciousness are ever produced in the laboratory, it must be because the elementary beings thus combined possessed life and consciousness in some lesser degree. By the combination the elementary parts fuse together so as to make something that we should recognize as resembling a natural organism.

However this may be, from the quotations and from the various definitions of the subject-matter of psychology as a science,

it becomes apparent that there is a very serious problem at issue. This problem is really one of philosophy, the question of the constitution of reality; more specifically, in the examples given, the issue between materialism and idealism or possibly dualism. Now, the whole outcome of the discussion of character hinges on the answer. In order to make intelligible my point of view, this problem must receive consideration, and that, too, at considerable length. For me the outcome is that reality is mental reality, not material. The pursuit of science in some sense may be freed from the difficulties of this controversy, but only by evading the issue, or rather by a determination so to state its aims and laws as to avoid the issue. In either case no strictly mechanistic conception of reality will hold. The method of procedure will be to examine some concepts of science in an attempt to discover in what sense they are intelligible.

So in attempting to define the science of psychology we have been confronted with a philosophical problem, the nature of reality. Our interpretation of character will depend on the answer. It has often been said that this is a futile quest, that metaphysics is a useless pursuit, that for ages philosophers have spun cobweb systems from their entrails, all different, no one of which is generally accepted. Let us, then, cease to philosophize and turn to science, where there is some general agreement. At first sight this attitude seems justifiable, but when one looks a little more closely difficulties appear. Science is in truth based on philosophy, however much some scientists would like to deny this.

"On the one hand the physicists cut up matter into molecules, atoms, corpuscles, and as many more such subdivisions as their future needs may make them postulate, and the units at which they arrive are uncommonly different from the visible, tangible objects of daily life. A unit of matter tends more and more to be something like an electromagnetic field filling all space, though

having its greatest intensity in a small region. Matter consisting of such elements is as remote from daily life as any metaphysical theory. It differs from the theories of metaphysicians only in the fact that its practical efficacy proves that it contains some measure of truth and induces business men to invest money on the strength of it; but, in spite of its connection with the money market, it remains a metaphysical theory none the less."[1]

There is no escape from philosophy, but philosophy has proved futile. In some way the philosopher must furnish a theory of life which shall induce people to "invest money" in it, which works.[2] Physics has done this, and perhaps the best way for the philosopher to arrive at a theory of life is through a critical examination of the metaphysical doctrine at the basis of physics. "When a certain way of looking at the universe meets with the extraordinary success with which that of physics has met, it becomes the duty of the philosopher to investigate it with care; for it is likely to offer a very much better Cosmology than his own unaided efforts can do. And, if philosophy is to take into account empirical facts — and it is extremely difficult to see what it will be able to tell us about the existent unless it does — it can hardly neglect the most fruitful and thorough investigation of certain large branches of empirical facts that has yet been made."[3]

But it may be doubted if physics taken in a narrow sense comprises all experience; there are the facts of biology and psychology which must be included. Our philosophical theory must be consistent with the facts of all the sciences. Impossible of fulfilment, you will say. It is difficult for one even to read all that

[1] Bertrand Russell, *Mysticism and Logic, and other Essays*, 1910, p. 126. (By courtesy of Messrs. Longmans, Green, and Company, New York.)

[2] Cf. John Dewey, "The Need for a Recovery of Philosophy," in *Creative Intelligence, Essays in the Pragmatic Attitude*, 1917.

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[2] Cf. John Dewey, "The Need for a Recovery of Philosophy," in *Creative Intelligence, Essays in the Pragmatic Attitude*, 1917.

[3] C. D. Broad, *Perception, Physics, and Reality*, 1914, Introd., p. vii. (Quotations are by courtesy of the University Press, Cambridge, England.)

is written in the field of any one science, to say nothing of all the sciences; and in my case I have no technical knowledge of any science except some slight acquaintance with psychology. Moreover, the facts of the various sciences cannot now be coordinated.[1] Yet in some way the task must be accomplished if any valuable theory of life is to result. This may be attempted by taking knowledge at second hand, by using summaries of the results of the various sciences. The only justification for such an attempt is that the various special scientists have not time enough; they often lose sight of the bearing of their special science on the general mass of knowledge. A philosopher with no other task has the time at his disposal to attempt this and can perhaps do it as well as any one else. Moreover, the philosopher must test his theories in some such way if they are to be of use. The only way that theories can be tested is by application to experience, and science is what we know about experience. So with great diffidence I want to set forth what science means to me, and especially at first to indicate what physics tells me about reality; and I want to do this in a sincere attempt to learn all that science has to teach. We shall see that in many instances scientists do not agree, that they have no generally accepted theory; a lesson is no doubt to be drawn from this, but I do not wish to attack science because it has not completed its task. Let us approach our problem in the spirit of Dr. Henderson, but from the philosophic rather than the scientific point of view; and as scientists we cannot do better than accept the attitude of Dr. Henderson as expressed in his interesting essay on "The Order of Nature":

"I have, therefore, after much hesitation, ventured to sketch the development of thought upon the problem of teleology, and at length to confront the scientific conclusions with the results

[1] Cf. Lawrence J. Henderson, *The Order of Nature*, 1917, p. 110.

of philosophical thought, in order finally to attempt a reconciliation.

"I fear that this task has been accomplished with feeble strokes. It was not undertaken confidently, but in the sincere belief that when such questions are involved men of science can no longer shirk the responsibility of philosophical thought. Only thus can they hope to escape from many errors, like those that weaken both sides of the vitalistic and mechanistic controversy, and that do really retard the advancement of science." [1]

In this spirit and with this understanding of the common aim of science and philosophy, let us turn to some of the underlying concepts of science.

[1] Henderson, *op. cit.*, pp. 8–9.

CHAPTER III

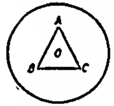
THE CONCEPTS OF SCIENCE

Let us begin our discussion with any object in the physical world — the desk on which I am writing. This desk is red, hard, smooth; it has a slight odor; if struck with a pencil a sound results; it has a certain weight, temperature, taste; it exists in space and time. It is made by man chiefly from wood, which is the product of a tree, which exhibits the phenomenon we call life. The ideal of physics is to describe this desk in some universal formula by reducing it to elements which are common to all objects in the physical world, and to explain it by assigning the causes that produced the desk. These causes are the antecedent events which are due to the properties of the ultimate physical elements according to the manner of their combination. The causal connection is a necessary one, and ideally can be expressed in a mathematical formula.

When one looks closely at the desk it is apparent that it has structure, that the wood is not homogeneous. The microscope shows that this is a structure composed of cells. Chemistry and physics divide these cells still further into various molecules, which are held to be formed from atoms. Atoms themselves are composed of parts or corpuscles, as is shown by the most generally accepted theories of radio-activity. Chemistry until recently held that atoms were indissoluble elements, of which about ninety are known; that different kinds of matter existed from which specific substances were built up. But it is now supposed that certain elements, like the radio-active ones, go through a process of transformation, so that one element evolves from another. Thus has gradually been formed the conception of a physical body as composed of an aggregate of two elements;

according to the way these units are arranged into atoms and molecules different chemical elements result, the combinations of which give the various substances known to science. These ultimate constituents of atoms are electrons and hydrogen nuclei, which are conceived as charges of electricity that may prove to be strains or vortices in the ether;[1] and it is possible that these vortices — matter — are destroyed and evolved anew.[2] An atom is, then, a physical object composed of parts, which is thus described by Sir J. J. Thomson:

"Let us picture to ourselves the aggregate as, like the Æpinus atom of Lord Kelvin, consisting of a sphere of uniform positive electrification, and exerting therefore a radial electric force proportional at an internal point to the distance from the centre, and that the very much smaller negatively electrified corpuscles are moving about inside it. The number of corpuscles is the number of units which had gone to make up the aggregate, and the total negative electrification on the corpuscles is equal to the positive electrification on the sphere. To fix our ideas let us



take the case . . . of three corpuscles, A, B, C, arranged within the sphere at the corners of an equilateral triangle, the centre of the triangle coinciding with the centre of the sphere. First suppose the corpuscles are at rest; they will be in equilibrium when they are at such a distance from the centre of the sphere that the repulsion between the corpuscles, which will evidently be radial, just balances the radial attraction excited on the corpuscles by the positive electrification of the sphere. A simple calculation shows that this will be the case when the distance of the corpuscle from the centre is equal to .57 times the radius of the sphere. Next suppose that the corpuscles, instead of being at rest, are describing circular orbits round the centre of the

[1] Bertrand Russell, *The A B C of Atoms*, 1923, pp. 26, 134, 141–143.
[2] Sir Oliver Lodge, *Life and Matter*, 4th ed., 1907, pp. 32–33.

sphere. Their centrifugal force will carry them farther away from the centre by an amount depending upon the speed with which they are rotating in their orbits. As we increase this speed the distance of the corpuscles from the centre of the sphere will increase, until at a certain speed the corpuscles will reach the surface of the sphere; further increases in speed will cause them first to rotate outside the sphere and finally leave the sphere altogether, when the atom will break up." [1]

What are these corpuscles that constitute an atom? Sir Ernest Rutherford says: "I personally am inclined to believe that all atoms are built up of positive electrons — hydrogen nuclei — and negative electrons, and that atoms are purely electrical structures." [2]

So you see that the elements which constitute matter are very active elements; they are charges of electricity, which is a form of energy; they are not at all like the old inert matter of physics. But some physicists believe that the physical world requires no matter whatever, that all is energy:

"All properties which physical bodies in contradistinction to geometric bodies possess can be traced back to a fundamental concept, which, in conjunction with the concepts explained in the former chapter, serves to characterize and distinguish the physical structure. For example, the fact that we can distinguish cubes of equal size but of different material, different temperature, and different luminosity, can be traced back always and entirely to the different kinds of energy acting in the geometric space in question. The concept of energy, therefore, plays approximately the same rôle in the physical sciences as the concept of thing in the formal sciences, and the essentials of this

[1] J. J. Thomson, *Electricity and Matter*, 1904, pp. 96–97. (Quoted by courtesy of the Yale University Press, New Haven.)

[2] Rutherford, "The Constitution of Matter and the Evolution of the Elements," in *Popular Science Monthly*, August, 1915, p. 142. (By courtesy of the editor of the *Monthly*.)

new field of science are the comprehensive knowledge and development of this concept. Because of its great importance it has long been known and applied in individual forms. But the systematization of the physical sciences relative to energy is a matter of only recent date." [1]

It is unnecessary and impossible to discuss the question whether energy can exist without something as its vehicle; in truth, energy as thus used is only a name for activity according to law. But the picture of the physical world is radically changed, whether we accept the view that the atom is a particle of substance bearing a charge of electricity or whether we regard it as electrical substance. "Thus, inevitably as science proceeds, the solid tangible material universe dissolves before its touch into finer and still finer particles, the unit quantities or 'atoms' of positive and negative electricity. The passive attribute of matter in occupying a definite volume of space to the exclusion of other matter resolves itself into an active dynamic occupation by virtue of the sweep of the electronic satellites in their orbits round the positive central sun." [2]

But, fascinating as such speculations are, the important point for us is that these physical elements, however constituted, do produce in some way the various attributes of the desk, the color, sound, hardness, size, weight; that the reality of the desk is not these attributes but is due to the activity of abstract entities which in some way produce sensations and *knowledge* in us; and this is true whether we conceive the elements as energy or as matter carrying energy.

In so far as the desk is a phenomenon in the physical world, physical science holds that it must have a physical cause. Among the causes for the appearance of the desk at a certain

[1] Wilhelm Ostwald, *Natural Philosophy*, translated by T. Seltzer, 1910, p. 128. (By courtesy of Messrs. Henry Holt and Company, New York.)

[2] Frederick Soddy, *The Interpretation of Radium*, 4th ed., 1920, p. 226. (By courtesy of John Murray, Esq., London.)

place and time is human agency. Since physics is to account for all phenomena, it must include this human agency. Of course this is not a problem that the physicist usually touches; but it is one that certain scientists like Watson, Loeb, and Verworn deal with, and they do it on the assumption that the physical description of the world as composed of aggregates which exist independently of mind, and which are causally connected, is sufficient to account for all experience.

The desk is in the room because, among other causes, a certain aggregate of electrons, a man, placed it there; this aggregate is the result, in so far as it is a physical body, of other physical aggregates. The way these physical aggregates behave is ideally expressible in the form of equations. In other words, the desk is made and placed in the room by man. Man is surely, in part, a physical object. All physical objects have cause for their activity. The physical causes for man's activity are very complicated, but ideally his body results from a process of evolution by natural causation beginning with the primeval nebula. This in turn must have been caused by something, and that by something else, and so on.

I have taken Dr. Henderson's book, *The Order of Nature*, as the text for much discussion and some criticism of the physical theory of reality. I have done this because the book is easily accessible and intensely interesting and suggestive; I admire it for its willingness to face and admit difficulties in the orthodox scientific way of looking at the world. If I criticize too, it is only because I think it does not go far enough in its analysis; and I am convinced that no one will interpret any criticism as an attempt to belittle or ignore what is a valuable contribution to scientific and philosophic thought. Of the mechanistic conception Dr. Henderson says:

"It is important to understand the foundation of the belief in mechanical determination, which seems to be as follows: The

world of physical science consists of matter and energy existing in space and time; in any particular case these four things are always to be represented by mathematical terms which are functionally related together in the equations expressing the laws of physical science. This functional relationship, although often unknown, is believed to be rigorously and unequivocally determined by the laws. Therefore, in accordance with the laws of conservation and the second law of thermodynamics, the non-mechanical, that is, any factor which is non-material, non-energetic, non-spatial, and non-temporal, cannot enter into or modify any physical or chemical process. Thus 'vital' processes can no more modify mechanical determination than mechanical processes can modify geometrical determination, and mechanism is conceived to be no less absolutely a condition of life than geometry of mechanics." [1]

Human consciousness, according to such a view, would be "a sort of delirium to which the world of the atoms is occasionally subject, — a delirium wherein the world forgets that it is nothing but an embodied system of differential equations, and takes itself to be — well, let us say: —

'An infant crying in the night,
An infant crying for the light,
And with no language but a cry.'

For just some such incorporated system of differential equations gone mad would be, according to such a theory, any conscious being, even if, for instance, he chanced to be that dignified and considerate speculative and mathematical physicist who, by hypothesis, is to be aware that all this account of Nature is true." [2] Or possibly some would prefer Goethe's description quoted by Mr. Bertrand Russell:

[1] L. J. Henderson, *The Order of Nature*, 1917, pp. 90–91.
[2] Josiah Royce, *The World and the Individual*, 1908, ii, 224–225. (By courtesy of The Macmillan Company, New York.)

"To Dr. Faustus in his study Mephistopheles told the history of the Creation, saying:

"'The endless praises of the choirs of angels had begun to grow wearisome; for, after all, did he not deserve their praise? Had he not given them endless joy? Would it not be more amusing to obtain undeserved praise, to be worshipped by beings whom he tortured? He smiled inwardly, and resolved that the great drama should be performed.

"'For countless ages the hot nebula whirled aimlessly through space. At length it began to take shape, the central mass threw off planets, the planets cooled, boiling seas and burning mountains heaved and tossed, from black masses of cloud hot sheets of rain deluged the barely solid crust. And now the first germ of life grew in the depths of the ocean, and developed rapidly in the fructifying warmth into vast forest trees, huge ferns springing from the damp mould, sea monsters breeding, fighting, devouring, and passing away. And from the monsters, as the play unfolded itself, Man was born, with the power of thought, the knowledge of good and evil, and the cruel thirst for worship. And Man saw that all is passing in this mad, monstrous world, that all is struggling to snatch, at any cost, a few brief moments of life before Death's inexorable decree. And Man said: "There is a hidden purpose, could we but fathom it, and the purpose is good; for we must reverence something, and in the visible world there is nothing worthy of reverence." And Man stood aside from the struggle, resolving that God intended harmony to come out of chaos by human efforts. And when he followed the instincts which God had transmitted to him from his ancestry of beasts of prey, he called it Sin, and asked God to forgive him. But he doubted whether he could be justly forgiven, until he invented a divine Plan by which God's wrath was to have been appeased. And seeing the present was bad, he made it yet worse, that thereby the future might be better.

And he gave God thanks for the strength that enabled him to forgo even the joys that were possible. And God smiled; and when he saw that Man had become perfect in renunciation and worship, he sent another sun through the sky, which crashed into Man's sun; and all returned again to nebula.

" 'Yes,' he murmured, 'it was a good play; I will have it performed again.'

"Such, in outline, hut even more purposeless, more void of meaning, is the world which Science presents for our helief." [1]

Such is the world of science if the laws and assumptions of orthodox physics are an adequate account of reality. Yet, if true, if this accounts for experience better than any other theory, we must accept it.

Dr. Henderson thinks he finds in the formulæ of J. Willard Gibbs such support for the mechanistic theory that there is no escape so far as the course of events is concerned, whatever may be the ultimate origin of events. These theories are stated in Gibbs's *Elementary Principles in Statistical Mechanics* and *Scientific Papers.* I do not wish, nor am I in the least qualified, to enter into the mathematics of such an inquiry. But in a matter of such importance it is necessary to understand something about how far and in what sense such equations will apply to the real world, taking the statements of the mathematicians themselves. Moreover, it is possihle and necessary to set forth and criticize the assumptions on which such mathematical demonstrations rest, for of course they are not evolved out of nothing.

Dr. Henderson concludes his exposition of Gibbs's theory in these words: "It is apparent, therefore, that Gibbs has provided physical science with a rigorous mathematical analysis of the conditions of equilibrium in any system and also in any ensemble of similar systems. I cannot pretend to understand more

[1] Bertrand Russell, *Mysticism and Logic*, etc., 1919, pp. 46–47. (By courtesy of Messrs. Longmans, Green, and Company, New York.)

than a little of Gibbs's analysis, and regarding the interpretation of his statistical inquiry I am obliged to rely upon help from the mathematicians. Nor should I wish to be understood as venturing to accept or in any way to pass judgment on all of the results. The presumptions are solidly in their favor, but time alone can test the productions of even so great a man. Yet this is clearly the best that we now possess as a means to the general and abstract physico-chemical characterization of cosmic evolution, for it involves our general concepts of matter, energy, space, and time, it includes the one known law of evolution,[1] the second law of thermodynamics, as an implication of its own more general results, and it is, so far as we can now see, rigorous, exhaustive, and exact." [2]

Let us for the moment accept Gibbs's analysis as being rigorous, exhaustive, and exact; but first, out of all fairness to him, it should be pointed out that there are certain limitations to his theory which are indeed recognized by Dr. Henderson,[3] though he apparently goes further than Gibbs and thinks the system applies to the real world. And let us refer to Gibbs himself:

"Moreover, we avoid the gravest difficulties when, giving up the attempt to frame hypotheses concerning the constitution of material bodies, we pursue statistical inquiries as a branch of rational mechanics. In the present state of science, it seems hardly possible to frame a dynamic theory of molecular action which shall embrace the phenomena of thermodynamics, of radiation, and of the electrical manifestations which accompany the union of atoms. Yet any theory is obviously inadequate which does not take account of all these phenomena. Even if we confine our attention to the phenomena distinctively thermodynamic, we do not escape difficulties in as simple a matter as

[1] Henderson here refers to Jean Perrin's *Traité de chimie physique*, Paris, 1903, ch. v.

[2] Henderson, *The Order of Nature*, pp. 133–134.

[3] *Ibid.*, pp. 131–132.

the number of degrees of freedom of a diatomic gas. It is well known that while theory would assign to the gas six degrees of freedom per molecule, in our experiments on specific heat we cannot account for more than five. Certainly, one is building on an insecure foundation, who rests his work on hypotheses concerning the constitution of matter.

"Difficulties of this kind have deterred the author from attempting to explain the mysteries of nature, and have forced him to be contented with the more modest aim of deducing some of the more obvious propositions relating to the statistical branch of mechanics. Here, there can be no mistake in regard to the agreement of the hypotheses with the facts of nature, for nothing is assumed in that respect. The only error into which one can fall is the want of agreement between the premises and the conclusions, and this, with care, one may hope, in the main, to avoid."[1]

Such is the theory on which Gibbs worked. What he thought he attained is again best given in his own words:

"But it should be distinctly stated that, if the results obtained when the numbers of degrees of freedom are enormous coincide sensibly with the general laws of thermodynamics, however interesting and significant this coincidence may be, we are still far from having explained the phenomena of nature with respect to these laws. For, as compared with the case of nature, the systems which we have considered are of an ideal simplicity. Although our only assumption is that we are considering conservative systems of a finite number of degrees of freedom, it would seem that this is assuming far too much, so far as the bodies of nature are concerned. The phenomena of radiant heat, which certainly should not be neglected in any complete system of thermodynamics, and the electrical phe-

[1] J. Willard Gibbs, *Elementary Principles in Statistical Mechanics*, 1902, pp. ix–x. (By courtesy of Charles Scribner's Sons, New York.)

nomena associated with the combination of atoms, seem to show that the hypothesis of systems of a finite number of degrees of freedom is inadequate for the explanation of the properties of bodies.

"Nor do the results of such assumptions in every detail appear to agree with experience. We should expect, for example, that a diatomic gas, so far as it could be treated independently of the phenomena of radiation, or of any sort of electrical manifestations, would have six degrees of freedom for each molecule. But the behavior of such a gas seems to indicate not more than five." [1]

It therefore appears to me that Gibbs expressly states that his theorems do not apply even to all physical phenomena, that they do not explain radiant heat, the electrical phenomena associated with the combination of atoms, and the phenomena exhibited by a diatomic gas. Is it fair, then, to assume that such theorems apply to such a complicated physical system as the human organism? Yet Dr. Henderson says that in some sense they do: "Every physico-chemical aggregation as such, that is to say disregarding the functional relations of its parts as in a machine, the structural configuration as in a crystal, and the infra-molecular characteristics such as the nature of molecular structure or the phenomena of radio-active transformations, may thus be ideally described. Often, as in the living organism, the actual task presents insurmountable difficulties; but these difficulties are practical, rather than conceptual or ideal. And no one, not even the vitalist, doubts that the organism is a Gibbs system." [2]

Dr. Henderson's argument, as I understand it, runs as follows: The human organism is built up of physico-chemical elements, electrons, or whatever they may turn out to be. To be

[1] Gibbs, *Elementary Principles*, pp. 166–167.
[2] Henderson, *The Order of Nature*, p. 181.

sure, there are such things as mental states, but whatever these may be they do not concern us as physical scientists. Gibbs's equations furnish a statement of physical laws that have the force of mathematical necessity governing the behavior of all aggregates of electrons having a finite number of degrees of freedom; although they do not express the laws of all material reality, we may confidently expect that some formula will be ultimately found which will do so. Therefore the behavior of a human organism must be governed by laws of statistical mechanics, must be determined by physical causation according to necessary law; the mental, if it has any existence at all, does not interfere with this order of events. In other words, it is generally agreed that an organism does in some sense obey the laws of physical chemistry, but no one holds that in the present state of science it is *proved* that the organism does not at the same time obey other laws. Nevertheless, many assert that the organism, in so far as it is an object in the physical world, is bound hard and fast by the laws of physical chemistry.

It is granted that the laws of statistical mechanics and consequently of thermodynamics do not explain even all physical reality. Yet Gibbs does give us a great, in fact the best, insight into the laws of the behavior of certain physical aggregates which we possess; rich men will invest money on his conclusions. In spite of its imperfections, it is not too much to suppose that these difficulties may be cleared up and that consequently some system of equations based on physical causation and the reality of a material world will be evolved whereby all physical phenomena will be expressed in mathematical formulæ according to the idea of Laplace. It is an incomplete and unproved conception that we are asked to base our theory of life upon, yet one that does account for a multitude of facts. This, I think, is a fair way of stating the argument on which Dr. Henderson's con-

clusion rests. It is, of course, my interpretation of the argument.

This reasoning depends on several assumptions which, if true, will, I believe, make Dr. Henderson's position unassailable. These assumptions are that an organism is in reality constructed of material elements, whatever else may be said of it, and that material elements are connected by necessary physical causal laws. It is these assumptions that we must now examine.

But, lest I be misunderstood, I must mention in passing that, in spite of this mechanistic interpretation, Dr. Henderson finds nature as a whole points to a deeper teleology. Moreover, his conception of nature and perhaps of the organism — although of this I am not so sure — is that they embody a teleological plan in a mechanism somewhat after the idea of Aristotle. This is a view that has the support of Mr. Bernard Bosanquet.[1] But, in spite of the almost superhuman authority adduced in favor of such a concept, it seems to me wholly unintelligible and actually to exclude purpose from the real world. To this point we shall return; for the present we are especially concerned with Dr. Henderson's materialistic assumptions.

Before we begin our examination of these assumptions, let me indicate again the importance of the answer for our study. If Dr. Henderson is right, then all human endeavor is an illusion. The world is a delirium like that described by Goethe; all is physical necessity; the study of character may be interesting as a pastime, but all characters are irrevocably determined by the physical conditions governing the primeval nebula. All my acts are ruled by an iron-bound external necessity, by physical causation; my conscious purposes are at best mere dreams.

Of course I insist, as yet without reason, that a human being cannot be *merely* a Gibbs system, and that any theory of

[1] Bosanquet, "The Meaning of Teleology," British Academy, *Proceedings*, 1905–06, pp. 235–245; quoted by Henderson, *The Order of Nature*, pp. 112–114.

reality founded on the implications of the Newtonian laws of motion, as are Gibbs's formulæ, is at bottom inadequate and unintelligible. Yet wealthy men will invest money on a belief in the validity of the Gibbs systems. How are we to preserve the truth of the physical metaphysics and yet attain a theory of reality that will work?

CHAPTER IV

PHYSICAL CAUSATION

LET us attempt the solution of this problem by asking on what metaphysical conceptions the equations of Gibbs rest. As I have suggested, they depend on the assumption of a material world and of necessary physical causation. But, lest we make unnecessary assumptions, once more let us turn to Gibbs and ask him to tell us from what his equations are derived. We learn that they are grounded on Hamilton's equations of motion.[1] Now, these equations of motion rest on, or at least imply, the Newtonian laws of motion, which in turn imply the law of causation.

My discussion of the idea of necessity in physical causation as illustrated by the Newtonian laws is based very largely on Mr. C. D. Broad's *Perception, Physics, and Reality,* which is by all odds the best presentation of this subject known to me. I of course interpret these results in a manner radically different from Mr. Broad, and I have illustrated and expounded his general idea at times in my own way and have introduced other views. It is therefore false to suppose that he is responsible for any views I may express, yet it is true that my conception of physical causation is due to him more than to any other authority.

The Newtonian laws of motion may be stated as follows: "(1) Every body persists in a state of rest or of uniform motion in a straight line unless acted upon by some external force. (2) The measure of the force acting upon a body at any moment in a given direction is the rate of change of momentum of the body in that direction at that moment. (3) For any pair of

[1] J. Willard Gibbs, *Elementary Principles in Statistical Mechanics,* 1902, p. 1.

bodies A and B which exert forces on each other the forces are equal in magnitude, have the same line of action, and are opposite in sense." [1]

Now, we should ask ourselves if these laws must be accepted as necessary truths. If they are so accepted, then there is apparently no escape from a position similar to that of Dr. Henderson: the laws of mechanics apply to the world of physics and, since our bodies are part of the physical world, they must obey the laws of mechanics and are determined in a strictly mathematical sense; they are Gibbs systems. This would hold, no matter what we eventually decide is the reality of the physical elements.

Mr. Broad points out that there are difficulties about defining the laws of motion, for motion can be regarded in two ways. It is either relative to some point regarded as a base or it is absolute. If you hold that motion is absolute, it is by no means easy to tell what you mean by motion. If you hold that it is relative, then it is extremely difficult to find a base; for even the fixed stars move. There are obstacles encountered in seeking an accurate measure of time. But for all practical purposes these difficulties are surmounted, and we shall disregard them, since other aspects are more important for our purpose.

1. In each of the laws we find the word *force* used. It will aid us in understanding what we mean by cause if we consider what force means. Not that the idea of force is necessary in the formulæ of Gibbs's statistical mechanics, but it is a word often used and it is well to try to understand its meaning.

2. In the first law we really have two statements: (*a*) a particle at rest relatively to the fixed stars will remain at rest unless acted on by some force (or cause); (*b*) a particle in motion relatively to this base will move in a straight line unless some cause intervenes.

[1] C. D. Broad, *Perception, Physics, and Reality*, 1914, pp. 276–277.

Let us consider this last statement first. It is held by Mr. Broad that the fact that a particle does move in a straight line unless some cause intervenes — that it does not, for instance, move in circles or stop — is a fact that can be learned only by experiment and is not a necessary or an *a priori* truth. If you throw a stone upon smooth ice, it will go in a straight line until it stops. The smoother the surface the farther it will travel. If you consider the surface as affording no friction and imagine the friction of the air removed, you reach the idea that the stone will move in a straight line unless interrupted by some force. Now this conception of motion in a straight line, combined with other motions, may be applied to motions of projectiles and to those of the planets. Experience shows that the theory works.

If this account be accepted, as I think it must be, much of the *a priori* necessity of a mathematical description of the world based on the laws of motion vanishes. The truth of the account as applied to a vast body of events remains, because this account does describe very many facts; it is only the necessity that disappears.

But we still have the assertion that a body at rest remains at rest unless acted on by some force. In this law is implied the broader postulate or axiom that every event must have a cause. In order to understand in what sense, if any, this axiom contains the conception of necessity, we shall have to examine what we mean by force and cause, ideas that are common to all these laws. Now, William James says: "We have no definite idea of what we mean by cause, or of what causality consists in. But the principle expresses a demand for *some* deeper sort of inward connection between phenomena than their merely habitual time-sequence seems to us to be. The word 'cause' is, in short, an altar to an unknown god; an empty pedestal still marking the place of a hoped-for statue." [1]

[1] James, *The Principles of Psychology*, 1890, ii, 671.

So apparently we have no easy task. Let us take a concrete, simple example. If I hurl a stone at a window and smash the glass, the stone in some sense may be called the cause of breaking the window. The stone is sometimes said to exert force imparted to it by my arm; the way it moves and the amount of force it exerts are held to be subject to description in terms of necessary law. When we look closer at what we mean when we say the stone exerts force and is the cause of breaking the window, difficulties arise. Stones do not jump up of their own accord and break windows; the cause then must be something peculiar to this stone — the fact that it is in motion. Motion imparted to the stone is the cause of the event. Now, what produces the motion in the stone is the motion of my arm, and the motion of my arm proceeds possibly from my will to move it; the force originated in my will works through my arm to the stone and eventually results in the broken window. Force, then, is perhaps something akin to the feeling of effort or activity I have when I hurl the stone or when I break the window directly by a blow. This feeling of activity is transferred from me to the stone, and we say that the stone exerts force in breaking the window, just as I should be conscious of exerting force if I broke it directly. In savage races and in very early stages of civilization this tendency to eject the feeling of effort takes the form of endowing objects with activity like our own wills (fetichism); later the tendency appears as polytheism, where different minds are believed directly to control phenomena. Thus thunder is regarded as the voice of God, and in the philosophy of the scholastics angels were supposed to guide the planets in their orbits.[1] The relics of this anthropomorphism are found in the idea of force.[2]

[1] J. E. Erdmann, *A History of Philosophy*, ed. W. S. Hough, 1890, i. 429. Cf. Auguste Comte, *Cours de philosophie positive*, 5th ed., 1894, i, 7–19; v, 1–237.

[2] Cf. Max Verworn, *Irritability*, 1913, pp. 19–20; Karl Pearson, *The Grammar of Science*, 1892, ch. iv.

The feeling of activity here referred to cannot be used as an argument for the reality of force, because it is probably possible to resolve this into sensations of movement of our bodies, thus making the feeling of activity an illusion.

But, even if there is a feeling of activity given in our consciousness, of course this does not prove that a stone or the planets move as the result of such an activity; they may or they may not. The stone in our example may move because I will it to move, or it may move because another physical event, the movement of my arm, which is itself determined by still other physical events, determines it to move.

If we say that the planets move, and that the stone moves because something like my own activity is imparted to it, we must be able to show what this activity or force does. One surely does not mean that the stone moves because it wills to do so. The stone moves because it is forced to move by my arm; but this idea of being forced to move means only that we observe that one event is always followed by or occurs with another. What else is observed or can be observed, except that the motion of my arm is followed by the motion of the stone and that this motion of the stone always follows when the conditions are fulfilled? To use the words of Hume, which apply to force just as much as they do to cause:

"Having thus discover'd or suppos'd the two relations of *contiguity* and *succession* to be essential to causes and effects, I find I am stopt short, and can proceed no farther in considering any single instance of cause and effect. Motion in one body is regarded upon impulse as the cause of motion in another. . . . 'Tis in vain to rack ourselves with *farther* thought and reflection upon this subject. We can go no *farther* in considering this particular instance.

"Shou'd any one leave this instance, and pretend to define a [cause], by saying it is something productive of another, 't is evi-

dent he wou'd say nothing. For what does he mean by *production?* Can he give any definition of it, that will not be the same with that of causation? If he can; I desire it may be produc'd. If he cannot; he here runs in a circle, and gives a synonymous term instead of a definition." [1]

The idea of force, then, is open to suspicion from its mode of derivation; the feeling of activity from which force is derived is probably nothing that can be held to be actually observed. Moreover, when we try to tell what we mean by force we are unable to say more than that there is a sequence of events which occur regularly and maybe necessarily. As to the necessity of the sequence we shall have more to say. It is apparent that the word *force* does not help us.

There is one more possibility contained in the simple example of a stone hurled at a window. You may say that, although the stone does not move by its own will and although my arm does not impart force to it, yet the real force at work is my purpose to break the window. This is what is known as a final cause and is different from the kind of force or causation we are now considering. We shall have to return to this many times. At present our purpose is to show that the laws of motion of bodies in the physical world are not *necessary* truths. Of course if final causes, our purposes, are operative in the physical world, the laws of motion are not necessary truths; yet these are to a certain extent true. Whether causation is to be ultimately resolved into final causation is a subject we shall have to consider, but at present we may postpone this.

I think, therefore, we may conclude that the idea of force adds nothing to the conception of causation or of causal or scientific law. As Karl Pearson says, "Force as cause of motion is exactly on the same footing as a tree-god as cause of growth

[1] David Hume, *A Treatise of Human Nature*, ed. L. A. Selby-Bigge, 1888, pp. 76–77. (Quoted by courtesy of the delegates of the Clarendon Press. London.)

both are but names which hide our ignorance of the *why* in the routine of our perceptions." [1] But if we remove from our idea of cause any conception of activity, we have left only the concept that cause is the necessary law, or laws, of the sequence of events. Let us, then, return to our example.

We have seen that the motion of my arm is an event which precedes the motion of the stone and is considered as the necessary cause of the motion of the stone. Now, my arm is part of my body and my body is part of the physical world. So the motion of my arm must be preceded by some other motion, and that by some other, until we get back to a first motion. But we can neither conceive of a first cause nor conceive of the world as governed by necessary causation without thinking of a first cause. This is, of course, Kant's difficulty, which may be found in his *Kritik der reinen Vernunft*, the third antinomy. Therefore as long as you hold that the idea of causation involves necessity you will be involved in this contradiction; so if the causal law cannot be stated without the concept of necessity it appears to be unintelligible. Before trying to solve this problem, let us consider another difficulty, which we can best do by examining other examples of causation.

When one stimulates by an induction shock the nerve of a nerve-muscle preparation from a frog, the muscle contracts. The electric stimulus is in some sense the cause of the contraction. But the muscle may be made to contract by suddenly pressing the nerve, by chemical stimuli, and by heat. Are all these powers, electric, mechanical, chemical, or other stimulation of the nerve, causes of the contraction of the muscle? Looked at more closely, it appears that a part of this process which we call contraction of muscle depends on the previous condition of the nerve and muscle. The stimulus would not have

[1] Pearson, *The Grammar of Science*, 1892, p. 144. (By courtesy of Messrs A. and C. Black, Ltd., London.)

produced its effect if certain atoms in the molecule of the muscle substance had not been in a peculiarly labile position; if certain chemical processes had not taken place in the course of the growth of the muscle, the stimulus would have produced no effect. The conditions existing prior to the application of the inductive shock are, then, part of the cause, or the necessary condition of the action of the cause. Again, these chemical processes of growth are conditioned by other prior processes, such as the digestion of food; and this again is conditioned by plant life, which transforms inorganic into organic matter suitable for consumption by the frog. So we see that the reaction of the muscle is determined by processes which are very remote, which are, in fact, the conditions of all the rest of the universe; but in this sense ideas of cause and of necessary causation become so spread out as to mean nothing, for if you should undertake to tell the cause of the contraction of the muscle you would theoretically have to enumerate in detail all the past history of the universe.[1]

Moreover, it is often impossible to state what is the cause of an event. If you put anhydrous carbonate of sodium in a beaker and add hydrochloric acid, carbon dioxide gas will be generated. Hydrochloric acid is the cause of the event. Now put hydrochloric acid in a beaker and add carbonate of sodium. Again will carbon dioxide be generated, but this time carbonate of sodium is the cause. Has the process, then, two causes or none at all? asks Verworn. For our next experiment we will put carbonate of sodium and hydrochloric acid in ether solution. There is no reaction, yet both causes are present. When water is added, carbon dioxide is again formed. Hence water is the cause. So one and the same process has many causes or none at all. In truth, the idea of cause is meaningless. What we find

[1] Verworn, *Irritability*, pp. 24–25. Cf. F. H. Bradley, *Appearance and Reality*, 1893, pp. 54–61.

are the necessary conditions or laws under which the process takes place.

Let us, then, says Verworn, throw over all attempts to use or define cause and say that what we really mean by causation is the formulation of necessary laws of the conditions under which phenomena occur. Of course we do not escape in this way from the difficulty, already noticed, that causation or causal law becomes merely the enumeration of all events in the history of the universe. This leads us to Mr. Bradley's criticism that such a view of causation is meaningless, to which we shall soon return. But I think we must admit that, supposing causation involves necessity, there is no escape for us.

But for scientific purposes, for all practical purposes indeed, this difficulty is more apparent than real; theoretically it is of great importance. Thus in our examination of the idea of necessary cause we have found, with Hume, that force seems to mean only the observed sequence; so that causation signifies that every event is determined necessarily by other events, usually prior in time. But this concept of causation involves us in Kant's antinomy, and in the difficulty that causation resolves itself into the enumeration of everything that is, or has happened, a process which is practically impossible if not logically so.

Let us take another example of causation. If we give Smith a dose of arsenic and assert that it will necessarily cause his death, this statement has meaning, from one point of view, only if we can enumerate *all* the conditions of the universe and know that nothing will interfere. For example, the existence and influence of the planet Mars is one of these conditions. But I think we may conceive of the annihilation of the planet Mars and yet feel certain that Smith will die, other conditions remaining the same. Again, suppose Smith is locked in a cell with his dose of arsenic in his stomach; the rest of the universe has small part in

the ultimate result. Thus by taking events as separated, for scientific and practical purposes, from the rest of the universe, the conception of causal law as descriptive of the way events occur can be of great scientific value. And this is really just what science does. The theoretical difficulty, that it is impossible to enumerate all the conditions, still remains; and, if we insist that scientific laws are necessary, I think there is no escape.

Let us then leave out the idea of necessity and see what will happen. We may safely say that Smith, locked in the room, will probably die. The probability under the conditions we have assumed amounts more nearly to certainty than what we usually call certainty in daily life. So if we say that the axiom, every event has a cause, means that every event has laws or conditions such that if certain conditions are given it is extremely probable that certain other *events will occur, then most* of our difficulties will vanish.

"The possibility of causal laws merely means that there is a certain amount of unity in the world, which, on further investigation, is found to take the form of a set of more or less isolated groups within which laws hold. In virtue of this fact the world is not a perfect chaos in which nothing can be legitimately expected at one time rather than another, but it is subject to certain laws such that the happening of one event or set of events, when known, has a legitimate influence on our expectation of the occurrence of other events. The fact that our knowledge of the occurrence of the events *B* strengthens our expectation of the occurrence of the events *C*, and that there were events *A* which, had they been known to have happened, would have strengthened our expectation of the events *B* and so on, presents no vicious regress. In fact there is no real analogy between causal explanation and logical proof. The only sense in which causal laws explain is that they simplify. They do not show us why an event happens in terms of some event or law that is self-

evident, for one event has no distinction from another to correspond to degrees of self-evidence among propositions. What they do tell us is that we can hope to know with some certainty what will happen where and when we cannot have or do not wish to have direct experience. It is in this sense that it is right to insist with Mach that their value is an economic one, whilst at the same time we definitely take our stand against the Pragmatists and deny (*a*) that this is what is meant by their truth, and (*b*) that it is a test of their truth. It is because it is true that they are of a certain definite nature, that they are of economic value to thought, and it is because predictions made by them are found to be verified by experience, that they are believed to be true. In this sense of explanation, which is the only one that causal laws will bear, the Kantian antinomy leaves them untouched." [1]

With this statement of causal laws I think we can agree. I should prefer to leave out the word cause and call them scientific laws; and I am not sure that justice is done to pragmatism. But unqualifiedly we may say that such a view of scientific law does escape the criticism of Kant, and that in so far as it is merely a practical affair, it also avoids the difficulty of Mr. Bradley. It moreover preserves all that science really needs, for the probability here is so much more certain than any certainty of daily life that the distinction between probability and certainty nearly disappears. This view incidentally banishes force from the categories of science; and the meaning of force, we saw, was difficult to grasp.

We started on this study of the meaning of natural causation because we wished to discover in what sense the laws of statistical mechanics of Willard Gibbs as interpreted by Dr. Henderson could be held to apply to reality. Dr. Henderson, we found,

[1] C. D. Broad, *Perception, Physics, and Reality*, 1914, pp. 158–159. Cf. Wilhelm Ostwald, *Natural Philosophy*, translated by T. Seltzer, 1910, pp. 47–53.

believes that these laws do govern reality in a rigorous, mathematical sense, so that all physico-chemical systems in the world are necessarily determined by the laws of statistical mechanics. We have seen that these laws rest on the laws of motion. An examination of the first law of motion showed that this law is not self-evident but is a generalization from observation of natural facts, that it is a consequence of the general law that every event must have a cause. This general law, we found, could be stated intelligibly only in this form, that events are linked together by probable laws which serve to simplify experience. These scientific laws have, to be sure, a very great degree of certainty and do give truth; they are not, however, *a priori* truths. It follows, then, that there is much probability that any given system in the world will be governed by the laws of statistical mechanics. It cannot be held, however, that any event *must* be so governed. Hume and Broad convincingly show that physical causation means only the probable expectation of the sequence of events.[1] No mechanical view of life is, then, of an *a priori* necessity, and in so far as the mechanistic view is founded on this assumption it falls. Even in a view of causation founded on physical premises there is not of necessity lack of room for final causes. The theory that causation means probable expectation preserves the practical value of scientific law. But, so far as we have gone, it leaves the world very much as before: it may be held that probably the world of science is as science describes it, although not necessarily so. And so we reach the second part of our problem: What reason is there for thinking that the world is not what science holds it to be, a non-mental reality independent of mind?

By examining the concept of causation on which the rigorousness, the necessity, of formulæ like those of Gibbs depends in so

[1] It is not intended to imply that simultaneous causation is impossible. See Broad, *Perception*, etc., p. 129.

far as they are held to apply to reality, we have seen that the necessity vanishes and a very great probability takes its place, a probability that for all purposes of daily life, for those of science, and for Mr. Bertrand Russell's money-market is as reliable as the idea of necessity. But this change in the idea of causation is of the greatest philosophical importance, for the conception of physical law as probability makes room for a world made up of a number of individual minds which are "striving to do something," which are acting according to their own inner natures, which are living out their own individual purposes. The idea of necessary causation excluded all teleological, all purposeful, activity from the world, at least from the world of physics. So there emerges the possibility of a theory of reality which holds that all existence is mental; that purpose, striving for an end, is the essential activity; that the world of science is this activity in so far as it has become fixed. The probability of the sequence of events is the probability that this fixed way of acting will not be broken. But new ways of acting may be formed and all old ways may be gradually modified; true evolution may take place. This theory makes possible a world like that so ardently defended by William James, perhaps even more explicitly in his life than in his philosophy, a world which, I think, he has perhaps best described in tl

were something really wild in the universe which we, with all our idealities and faithfulnesses, are needed to redeem; and first of all to redeem our own hearts from atheisms and fears." [1]

Let me state the problem again from a slightly different angle. We have seen that the world of orthodox physics is a world of something, either energy or a substance carrying energy, which is independent of mind but which in a way gives rise to mind and causes the ideas we have in our minds — our sensations, feelings, thoughts. If physical causation is necessary, then there is no room in such a world for the activity of mind. Physical causation is not necessary but is a very probable sequence. We have thus far, then, merely reached the point that there is logically room even in this physical world for events not physically caused, there is room for the activity of mind. Are there any positive reasons for thinking that mental activity is a part or the whole of reality? Is there any reason for thinking that the substance of physics is really mind, that the laws of physics are the laws of the permanent reactions of mind, that the world is a mental world? Or must we conclude that physics is right, that reality exists independent of mind and that the world is probably, though not necessarily, to be described in the terms used by Goethe? Or, possibly, must we conclude that there is no answer? These problems may be approached through an examination of the physical theory of a world which exists independent of mind.

[1] James, *The Will to Believe, and other Essays in Popular Philosophy*, 1897, p. 61. (Quoted by courtesy of Messrs. Longmans, Green, and Company, New York.)

CHAPTER V

REALITY INDEPENDENT OF MIND

You will remember that, whether we accept the atomic theory or the energetic theory, we get a new picture of reality; the world of physics is no longer inert and passive, it becomes a world of intense activity. Whether this physical world eventually turns out, from the point of view of science, to be a world of disembodied energy or of substance carrying energy is for our present purpose a matter of indifference. The common and important aspect of both theories is that some kind of substance, whether matter or energy, is the ultimate reality; that this something acting in space and time produces for us all the qualities of the external world — the redness, hardness, weight, size, of the desk on which I write.[1] So Dr. Whitehead, considering the nature of a physical explanation, says: "During the modern period the orthodox answer has invariably been couched in terms of Time (flowing equably in measurable lapses) and of Space (timeless, void of activity, euclidean), and of Material in space (such as matter, ether, or electricity)."[2] The common and philosophically important aspects of such views of physical reality are that reality exists independent of all mind and that knowledge of such a reality is possible. There are two interpretations of this independence. The extreme view, that of the materialists like Verworn and Loeb, is that the physical reality is sufficient to explain all experience; the other belief is that the

[1] Cf. Rutherford, "The Constitution of Matter," etc., in *Popular Science Monthly*, August, 1915, pp. 106–107; Henderson, *The Order of Nature*, 1917, p. 90.

[2] A. N. Whitehead, *An Enquiry concerning the Principles of Natural Knowledge*, 1919, p. 1. (Quoted by courtesy of the University Press, Cambridge, England.)

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world is dualistic, that mind exists and also matter which is independent of the fact that any mind thinks it. The extreme view of physical reality need not detain us long, not only because its argument is manifestly absurd but because of the more fundamental criticism applying to both interpretations — that a world independent of all mind is inconceivable.

In the materialistic theory certain statements are made about this physical world conceived as an explanation of all reality. (1) Starting from a non-mental world of, let us say, electrons, we finally get the mind of the physicist or observer; (2) it is also assumed that the physical world is a closed system in which matter and energy are sufficient to account for all occurrences, even motions of our bodies, and that all matter and energy are in this way used up. But even for physics minds or at any rate thoughts exist, at least as phenomena. So the question immediately arises, How can physical science taken in its broadest sense account for minds?

One of the most common explanations is that we know molecules and physico-chemical energy exist. We must think of nature as a uniform process; we cannot think of an absolutely new kind of being as resulting from this process; therefore mind must be some form of physico-chemical process. But this argument from continuity is a double-edged sword that cuts both ways. If you start with the assertion that mental entities exist, and if nature is uniform, then going down the scale you must suppose that in some way electrons are mental entities. If you say that both minds and electrons exist, then you must suppose that electrons carry minds and you give up a true physical explanation. So the argument from the continuity of nature does not help the materialist in the least.

Moreover, a much more serious difficulty is involved. The conception that mind is a mode of motion is unintelligible. Starting at one end of the process of evolution you have elec-

trons in motion; but when you reach the other end you have a mind which in some way attains truth, you have pleasures, pains, loves, hates, fears, scientific truths, ideals of conduct. Now, a pain, a toothache, is not a motion of electrons or molecules. The motions of electrons form a closed system; all their matter and energy are used up and accounted for in the various parts and activities of our bodies, nothing is left to make a pain. But even if we could conceive of something left over, so to speak, yet we cannot conceive of the motion of molecules being a pain; a spiral motion or a more ample vibration or a rotary motion is not a pain.[1]

The detailed criticism of attempts to get round this difficulty — epiphenomenalism, parallelism, and the two-aspect theory — we shall reserve until later, when we reach the problem of the relation of brain to mind. Such examination is the more unnecessary at present because we have a still deeper criticism of the physical theory of a world independent of mind. This conception, as ordinarily stated, consists in the assertion that mind exists and so does matter; that in some way mind knows matter and reaches truths, but that the laws of nature form a closed system independent of mind sufficient to account for all events in the physical world, including the motions of our bodies. Now, these conceptions are implied also in a materialism which states that mind is a mode of matter; for even the materialist holds, implicitly at least, that his mind knows truth and that this reality which is known is independent of his mind and of all mind. We are thus led to a fundamental criticism of the concept of orthodox science — to the position that a reality independent of all mind is unintelligible.

Both science and common sense assume that some sort of knowledge is possible, and with this conclusion philosophy must agree. It must agree because science has formulated laws about

[1] Cf. James, *Psychology*, 1890, i, 146–150.

experience which are found to work, which help us to control experience. Science ordinarily assumes that reality exists independent of all mind. It is necessary, therefore, that a complete scientific theory should state intelligibly how such a reality can be known. This problem may perhaps be best approached through Bishop Berkeley's criticism of the concept of a material reality, an excellent exposition of which has been given by Josiah Royce.[1]

Berkeley's criticism is, in brief, that we know external objects only through ideas or perceptions or thoughts. Thus a chair is described as having certain qualities: it is red; if beaten with a stick it emits a dull sound; it gives forth a certain odor; if touched by the tongue it will give a certain taste; it has a certain temperature; it is hard, heavy, of a definite shape. Some of these qualities, as sound, taste, smell, and color, are considered unanimously by common sense, by physics, and by Berkeleyan idealists as being ideas or perceptions in the mind of the observer and not as real properties of the object. Thus, if we examine the chair through a microscope the color changes; to some who are color-blind the red does not exist. Moreover, a cloud at a distance appears red; if we enter it there remains only a gray mist: color is not in the object but in the mind of the observer. Sound is not a quality of the chair; certain vibrations perhaps are, but the idea of a symphony is not merely vibrations, it is something mental. Taste and smell cannot belong to the object, for they depend on our own minds: if we have been eating lemon the coffee will taste sweet, if we have been eating candy it will taste bitter. If we come into the house from the fresh air, all smells close and musty; but to those who have been indoors the air is sweet. If we warm one hand and cool the other, the chair may

[1] George Berkeley, *A Treatise concerning the Principles of Human Knowledge*, 1710 (*Works*, ed. A. C. Fraser, 1901, i, 211–347), and *Three Dialogues between Hylas and Philonous*, 1713 (*ibid.*, pp. 349–485); Royce, *The Spirit of Modern Philosophy*, 1892, lecture xi, "Reality and Idealism."

feel cold to one hand and warm to the other. These secondary qualities, then, are ideas in the mind of the observer, not permanent properties of the object.

But what of the other qualities of the chair, its size, shape, weight? These appear to be real properties of the object. But, says Berkeley, ask yourself, I pray you, what you mean by size and shape, by the fact that objects exist in space. You mean simply that under certain conditions you get an idea of a certain space. This is the result of experience and of the laws of my mind, but the only way I know space is through the idea I have of it; likewise I know weight only through ideas. So all the qualities I attribute to the chair are known only as ideas. If there is more to the chair than ideas and the laws of ideas, I can never know it, for all knowledge is knowledge of ideas. "Some truths there are so near and obvious to the mind that a man need only open his eyes to see them. Such I take this important one to be, viz. that all the choir of heaven and furniture of the earth, in a word all those bodies which compose the mighty frame of the world, have not any subsistence without a mind." [1]

But, as James somewhere says, real fires burn, ideal fires do not; and Dr. Johnson showed his contempt for the Berkeleyan idealism by stamping on the pavement. Although these gentlemen are undoubtedly right, there is also some truth in Berkeley's contention. James and Johnson emphasize the fact that the real world is different from the imagined world, that sensation is not imagination, that each of us must believe in a reality other than his individual mind But Berkeley is right in holding that the real world, when known to me, is a content of my consciousness. What contents, what ideas, do we regard as real, what as imaginary and internal? Is there any mark that always distinguishes those contents which we refer to the external

[1] Berkeley, *A Treatise concerning the Principles of Human Knowledge*, 1710 (*Works*, ed. Fraser, i, 260) (Quoted by courtesy of the delegates of the Clarendon Press, Oxford)

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The problem of a reality which is other than the mere private flow of fancy may be separated provisionally into two aspects which ultimately resolve into one — the belief in other minds and the belief in a material world. Either of these beliefs supposes a reality, a stuff, a something that persists and acts and exists, other than the idea or mind or thought conceiving it. This something may be called substance, and is so called by Dr. Santayana for instance. It is this substance that, according to Dr. Johnson, would, I suppose, distinguish, would furnish the mark, between real and imaginary ideas. When we search for what intrinsic marks this substance exhibits we meet difficulties, and especially when the substance is held to be different and distinct from all minds. Let us, then, examine this belief in external reality, in substance whether material or immaterial, keeping in mind the two provisional aspects — the belief in any external reality and the belief in a material external reality.

The ultimate reason for our belief in any external reality is that we believe all our ideas are real unless something forces us to disbelieve in them. Most children in my day believed in the actual existence of Santa Claus. Only bitter experience makes this belief untenable. As Spinoza says: "Let us conceive a boy imagining to himself a horse, and taking note of nothing else.

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As this imagination involves the existence of the horse, *and the boy has no perception which annuls its existence,* he will necessarily contemplate the horse as present, nor will he be able to doubt of its existence, however little certain of it he may be. I deny that a man in so far as he imagines (*percipit*) affirms nothing. For what is it to imagine a winged horse but to affirm that the horse (that horse, namely) has wings? For if the mind had nothing before it but the winged horse it would contemplate the same as present, would have no cause to doubt of its existence, nor any power of dissenting from its existence, unless the imagination of the winged horse were joined to an idea which contradicted (*tollit*) its existence." [1]

But our experience does contradict winged horses; and finally, by the various contradictions of reflective thought, we reach a view that makes possible a formal doubt of the existence of all save thought, — not the *Cogito ergo sum* of Descartes, but mere thought, mere experience, the fact that there is some kind of existence. We must believe, because there is nothing to contradict it, that this present thought we now have exists and is real. Actually, of course, we believe more than this; we believe in our own minds as some sort of entities, and in other minds just as fervently as we believe in our own, and also in the objective reality of a world of objects. We do this because without such beliefs we cannot unify experience, react to it, and make it intelligible, and because experience does not contradict them but on the whole corroborates them.[2]

The ordinary view is that our ideas immediately give us some knowledge of the real, external world, that they have some mark or character which gives reality. For example, it is sometimes

[1] Spinoza, *Ethics*, ii, 49, Scholium; quoted by James, *Psychology*, ii, 288. (Requoted here by courtesy of Messrs. D. Appleton and Company, New York.)

[2] Cf. James, *Psychology*, ii, 299–306; and Royce, *The Religious Aspect of Philosophy*, 1885, pp. 317–357.

held that the real is what is independent of our wills and that this independence is a mark of external reality. If we consider any concrete object in the physical world, as a chair, one aspect is at once apparent: the idea of the chair comes to us under proper conditions independently of our wills. But, as Royce so vividly points out, mere independence is not enough, much that is wholly mental is just as strikingly independent. "The lonely wanderer, who watches by the seashore the waves that roll between him and his home, talks of cruel facts, material barriers that, just because they *are* material, and not ideal, shall be the irresistible foes of his longing heart. 'In wish,' he says, 'I am with my dear ones, but alas, wishes cannot cross oceans! Oceans are material facts, in the cold outer world. Would that the world of the heart were all!' But alas! to the rejected lover the world of the heart *is* all, and that is just his woe. Were the barrier between him and his beloved only made of those stubborn material facts, only of walls or of oceans, how lightly might his will erelong transcend them all! Matter stubborn! Outer nature cruelly the foe of ideas! Nay, it is just an idea that now opposes him, — just an idea, and that, too, in the mind of the maiden he loves."[1] Stubbornness against the will is, then, not enough; mental facts are stubborn as well as material facts. It is a special kind of stubbornness that makes us think of certain ideas as external material realities. If the conduct of the maiden is regarded as something that may be observed by all minds, in the way a psychologist might observe it, then her stubbornness is held to be a mark of material externality: the maiden with her stubbornness becomes a real object. If the youth regards the maiden's mind as something concerning merely himself and her, then her stubbornness is external to him indeed, it is real, but not necessarily a part of physical reality. If he should regard his

[1] Royce, *The Spirit of Modern Philosophy*, 1892, pp. 352–353. (Quotations are by courtesy of Houghton Mifflin Company, Boston.)

idea of her stubbornness as perhaps merely his private opinion, then this idea of stubbornness would not have any external reality at all. Stubbornness as a mark of externality means that it is a kind of stubbornness which is the property of several minds; that when it is a mark of material externality it is a stubbornness which is common to you, to me, and to the object.

The idea of a chair is also permanent, as long as my eyes are open and there is sufficient light and as long as my attention is turned to it; whereas ideas of the fancy come and go. But the remorse of Orestes is even more permanent: flight over land and sea, indeed sleep itself, hardly removes the accursed idea. Orestes's remorse, however permanent, may be a pathological remorse which has reality for him but is not recognized as a part of external reality — except as illusion — unless it is known by other minds Permanency as an intrinsic character of an idea is insufficient to establish belief in its reality. Of course permanency of ideas considered as a mark of external reality means more than this: it means that the object may be perceived by you or by me whenever the right conditions are fulfilled; it means that there is a permanent possibility of experiencing an idea which is common to you and to me; and this implies that the object has some kind of permanent existence when neither you nor I perceive it. It means, in other words, that there is existence of some sort common to you and to me and to the object.

So it would seem that ideas which are common to you and to me and to the object are what we regard as externally real. Under certain conditions we get certain ideas; these we are able to describe to each other and finally to agree that we have these ideas in common. But even this fact, that ideas of the external world are held to be common property, is an insufficient criterion of external reality; for a concept of mathematics — for example, the idea that the circumference of a circle bears a rela-

tion to the radius which is expressed by the formula $2\pi R$ — is common to both you and me but is not necessarily a mark of external material reality, for conceivably there might be no such things in the real world as circles. Nevertheless, agreement on the validity of such an idea makes it more than mere fancy. But the belief in its validity depends on another belief — on that of the existence of other minds. Let us suppose that out of my fancy I construct a five-dimensional geometry. The reasoning appears cogent to me and I hold it valid. Now let us suppose that mathematicians agree that such a geometry is a logical construction from given premises. Then my five-dimensional geometry has a validity apart from my private fancy. If others hold that my reasoning is faulty, then my geometry is without validity, is mere fancy. Common agreement does, then, furnish a mark of validity of an idea which distinguishes it from mere imagination. But does this constitute a mark of its extra-mental reality? Is the real external world a five-dimensional one, a four, or a three? Do circles really exist? Only experience can answer this. We must for some reason believe that circles are real before we believe that these valid mathematical demonstrations are a mark of reality. Moreover, this belief that the validity of a demonstration is given by common consent assumes that other minds exist, and as yet we do not know that such a belief is justified. Community of ideas, then, while distinguishing between private flights of fancy and a valid exercise of the imagination, does not, even if other minds are given, furnish a mark of external material reality.

Nor are ideas of reality necessarily different in clearness, vividness, or intensity from those of the imagination. We can have just as clear an idea of a sea-serpent as of an ordinary snake, and our imagined picture may be just as vivid as reality, as is actually the case in dreams. But the sea-serpent is not held to be an external reality unless you and I agree that it is external.

And mere intensity is not an intrinsic mark of ideas. For instance, sensations of color can exist in various degrees of intensity, and my imagined ideas of these various sensations can also differ in the same way. Moreover, illusions and hallucinations show that vividness and intensity, as intrinsic marks of ideas, do not necessarily constitute what we call reality. It is only when we agree that the object has these qualities that they become a mark of externality.

There are other qualities of sensations, of the immediate flux that we are considering. They all have extension, they have a certain "spatial *quale*"; besides, they overlap — one is fading or departing, another is appearing. They have duration. a quasi-temporal quality which is not of course a developed concept of time any more than the spatial *quale* is our concept of space. It is not generally agreed that these are qualities of sensation; but, even if sensations do possess them, these qualities are insufficient to distinguish what is externally real from what is not, for, again, dreams and hallucinations have these spatial and temporal qualities. Only when they are regarded as common to you and me and the object do they become marks of external reality.

There is a peculiar quality that attaches to those ideas which we ordinarily attribute to reality. It is one that is common to all sensations — their immediacy, their own individual tang. This is an indescribable and irreducible quality. But this immediacy is not enough in itself to distinguish those ideas which we regard as being real Apart from hallucinations and dreams, which have the same poignancy as sensations, we realize that some sensations are, so to speak, more real than others. Thus odors are generally classed as ideas, as subjective things, caused, it is true, by outer objects but still merely ideas; and so in a large measure are tastes, visual sensations, and sounds. But when we come to the sense of touch, according to Mr. Broad, there is a

difference; touch gives more reality than any other sense; it furnishes the mind with ideas of a special kind which have greater reality, for if we can touch a thing it seems to us more real. Touch gives more reality because it presents ideas of geometrical form, and it is not unreasonable to suppose that the real world has geometrical form. These geometrical forms have a certain validity even as mere fancy. Do we not, then, in the sense of touch arrive at something that is truly real? So for Mr. Broad the sense of touch does give reality because it has immediacy; all other sensations are referred to it; it apparently gives verifiable information that is common to all. The ideas it furnishes are permanent and independent of our wills; they also fit in with all our experience. I believe that psychologically this account is largely true; but, unless ideas of touch giving geometric form were common to you and me and the object, we should not think them marks of reality. If I said an object felt round and you said it felt square and another said it felt hexagonal, we should never think that touch gave reality.

Ideas, mental contents, have still other characteristics; they are all tinged with agreeable or disagreeable or possibly indifferent qualities; they have values. The value of any content is in one sense my feeling toward the object, but in another sense it is part of the object. A human being as object of my thoughts is not merely a vivid, permanent unity of a mass of sensations in the usual use of the term; it is a unity that also has feelings of the agreeable or the disagreeable. Nor can feeling be restricted to human objects; apes, dogs, birds, snakes, clams, amœbæ, have elementary feelings; at least it is impossible to say where feeling begins. For take the human germ-cells. Out of them in some way the human mind results. The germ-cells are themselves perhaps organisms made up of still smaller organisms which may be so minute that they cannot be discerned by the microscope, as are some bacteria; and these organisms are in

turn composed of molecules and atoms and electrons. Where does feeling first arise? Here again my own private idea, my feeling, when considered as a content possessed by you and me, the amœbæ, and the electrons, is a part of external reality. But this feeling, when it is regarded as a property common to several minds and to the object, may also be considered as a part of objective material reality. For, again referring to James: "Is the preciousness of a diamond a quality of the gem? or is it a feeling in our mind? Practically we treat it as both or as either, according to the temporary direction of our thought. 'Beauty,' says Professor Santayana, 'is pleasure objectified'; and in Sections 10 and 11 of his work, *The Sense of Beauty*, he treats in a masterly way of this equivocal realm. The various pleasures we receive from an object may count as 'feelings' when we take them singly, but when they combine in a total richness, we call the result the 'beauty' of the object, and treat it as an outer attribute which our mind perceives. We discover beauty just as we discover the physical properties of things." [1]

The linkage of those ideas that represent the external world is held to be different from mental sequences. Objects are found in causal relations, ideas in logical and purposive relations. But take Einstein's theory of relativity. At first this is an idea in Einstein's mind. He believes it true because it fits with what he thinks is experience. He is not able actually to prove it until he can bring it into accord with experiences that are common to both you and him, — experiences of the behavior of planets, let us say. When this private idea becomes a part of our common experience it is attributed by both you and him to an external world, but not till then. Thus it is with all linkages of facts. They do differ, but the ultimate criterion of reality is that the linkage shall be common property.

[1] James, *Essays in Radical Empiricism*, 1912, p 143 (Quotations are by courtesy of Messrs Longmans, Green, and Company, New York.)

Ideas appear active. Do ideas that we regard as belonging to the external world have any special kind of activity? This is a difficult subject. As has often been pointed out, the feeling we have when we think we are active, as for instance when we are striving to solve a problem and our whole being is tense, is largely a lot of sensations in the muscles of the head; but over and above this there appears to be a guiding principle. If we are seeking the answer to a philosophical problem, something different is going on from what happens when we are trying to find ways and means for our next meal; it is different because apparently it gives different results. This activity can be stated only as a creative process of the imagination, as purpose more or less explicitly defined in thought. It guides the changes in thought in a very definite way; it seems to be what brings about the changes. If it is mere urge, then it is not activity with a definite end in view; it is, nevertheless, essentially the same kind of thing. This sort of activity, which is a property of certain ideas, is often regarded as nothing but my subjective activity.

But, when we look at the ideas which we call external or as representing externality, we find that they are active too. The electrons of some atoms are changing constantly in space and time; they are changing in accordance with certain principles that belong to the idea of electrons. They do not change, so far as we observe, because they put a definite goal before themselves, but because there is in the electrons this kind of change. If you ask in what this activity consists, there is no answer except that it is observed change, unless you impute to the electrons something akin to the activity of conscious thought. Everything is active and changing, thought and things. What is activity? Well, it is either merely observed sequence common to ideas both of the imagination and of objective reality, or it is activity of the same nature as we observe in our consciousness, — not sensation, perception, or feeling of change in the

body, but an immediate awareness of change in a given direction, implying that something is active. The activity of material objects is that part of this activity which we believe common to you, to me, and to the object.

If change is mere observed sequence, then what distinguishes the kind of change we attribute to the external is that kind of change which we find common to us all. But again, if change is of the nature of purpose, as I believe it is, then objective change is purpose which we observe as common to you and to me and to the object.

It may be objected that to explain activity by reference to mind is explaining the known by the unknown, that it is using the result of evolution to explain the beginning. But even evolution is a system of ideas, we know its elements only through the exercise of our completed intellect; so in a sense all explanations of evolution involve the use of the final product, mind. The only way we can find out anything about experience is by observing our ideas, which are in a state of what we call change. By observing this striving and change can we form any intelligible idea of what this change, this activity, is? I think we can, but I think it can be stated only in terms of purpose or of blind striving. For even in blind striving there apparently must be a direction. When this direction becomes explicit in consciousness, then it is purpose. "'Change taking place' is a unique content of experience, one of those 'conjunctive' objects which radical empiricism seeks so earnestly to rehabilitate and preserve. The sense of activity is thus in the broadest and vaguest way synonymous with the sense of 'life.' . . . Bare activity would thus be predicable, though there were no definite direction, no actor, and no aim. Mere restless zigzag movement, or a wild *Ideenflucht*, or *Rhapsodie der Wahrnehmungen*, as Kant would say, would constitute an active as distinguished from an inactive world." [1]

[1] James, *Essays in Radical Empiricism*, pp. 161–163.

"If we take an activity-situation at its face-value, it seems as if we caught *in flagrante delicto* the very power that makes facts come and be. I now am eagerly striving, for example, to get this truth which I seem half to perceive, into words which shall make it show more clearly. If the words come, it will seem as if the striving itself had drawn or pulled them into actuality out from the state of merely possible being in which they were. How is this feat performed? How does the pulling *pull?* How do I get my hold on words not yet existent, and when they come by what means have I *made* them come? Really it is the problem of creation; for in the end the question is: How do I make them *be?* . . . Sustaining, persevering, striving, paying with effort as we go, hanging on, and finally achieving our intention — this *is* action, this *is* effectuation in the only shape in which, by a pure experience-philosophy, the whereabouts of it anywhere can be discussed. Here is creation in its first intention, here is causality at work." [1] Once more, whatever the nature of causality or change, the fact that it is common property is what constitutes its externality.

One more characteristic of ideas must be mentioned, and this is the fact that experience, the flow of ideas, is possible only through an activity of thought. If I am absorbed in my problems, the noises of the street are banished from consciousness; I may even look at the chair and not see it. Psychology shows us that the physical conditions for the formation of double images of objects must often exist, although we usually see objects as single; furthermore, that we may learn to attend to these double images and train ourselves to see them. We habitually neglect the blind spot in our retina, though by suitable attention we may become conscious of it.[2] If I am absorbed in the contemplation of God, the facts of science and perhaps even those of evil and suffering cease for me to exist. If I am enjoy-

[1] James, *Essays in Radical Empiricism*, pp. 181–184.
[2] James, *Psychology*, ii, 240–269.

ing a sunset, the theory of cosmic evolution is not usually present to my consciousness. As for the amœba, if it be supposed to have mentality at all, most of what may be present to me is impossible for it. The very material of experience depends, then, in part on the way mind reacts. When we say a chair is really there, we imply that your mind and my mind react in the same way and get from the reaction a similar result. If it is merely my personal reaction I do not call the idea external.

So we believe that our ideas represent an external reality, primarily because all ideas are believed in as real unless something prevents. Experience forces us to doubt that all our ideas are real, and gradually we find out that those which have a vivid, intense tang of immediacy, which are also permanent, causally active, stubborn, and referable to the sense of touch, are more likely to be real. It is only when such ideas are found by experience to be common to you and to me and to the object that they are accepted as marks of objective reality, as having substantial, material existence.

"In that perceptual part of *my* universe which I call *your* body, your mind and my mind meet and may be called conterminous. Your mind actuates that body and mine sees it; my thoughts pass into it as into their harmonious cognitive fulfilment; your emotions and volitions pass into it as causes into their effects.

"But that percept hangs together with all our other physical percepts. They are of one stuff with it; and if it be our common possession, they must be so likewise. For instance, your hand lays hold of one end of a rope and my hand lays hold of the other end. We pull against each other. Can our two hands be mutual objects in this experience, and the rope not be mutual also? What is true of the rope is true of any other percept. Your objects are over and over again the same as mine." [1]

[1] James, *Essays in Radical Empiricism*, pp. 78–79.

It may be said that the external ideas of electrons in motion are agreed by all to be common ideas and so really to constitute reality, whereas some of these other ideas, as activity and personality, are not regarded as marks of externality. What is by common consent called real is electrons, not minds; for the agreement of all minds is what constitutes the final test of reality. Now this test itself rests on the agreement of all minds that other minds exist; that other minds exist is apparently a deduction from experience by an argument from analogy, and is really an argument in a circle. So this belief in the actual existence of the world of electrons is dependent for its proof upon the existence of other minds. If you deny the existence of the mental, then the material world vanishes. Even for science other minds are necessarily assumed to be real.

We believe, then, in this external material world largely because we believe in other minds, or at least in another mind. How do we come by this supposed knowledge of other minds? I imagine the answer is somewhat as follows: Although it is dangerous to dogmatize about the mind of an infant, we may perhaps form some vague idea of its general outlines and describe tentatively how the belief in minds and in bodies is actually evolved. We may picture to ourselves the mind of an infant as a bustling, buzzing "bloom of confusion." In this confusion all sorts of sensations from what we call the material world, and from its own body in the form of pains, agreeable and disagreeable feelings, and strivings, form a whole in which parts are not as yet discriminated. But this whole is all real, and equally real. There is no question of mind or body or of differences of any sort. For the infant a certain part of this total confusion, a certain group of sensations, acquires great interest, — its mother at feeding time. It begins to observe this interesting part of its universe and gradually to discriminate it from other parts, — from the chair in which it is confined, for instance. It observes

in a vague way that its mother acts differently from the chair Gradually, either by being taught or by instinctive tendency, the infant imitates its mother, it smiles, it begins to make gestures like its mother, to talk In this way it gets new and, presumably, agreeable experiences When it explores its chair, no such active pleasurable experience results Little by little it begins to form an idea that a part of its total reality, its mother, is more active and pleasurable than another part, the chair

Moreover, the infant by its own activities and by imitation begins to get an idea of its own body as a more intimate, interesting, pleasurable or painful, part of reality than the chair Gradually the idea of its mother emerges as a being similar to itself, as a reality that also enjoys A chair is not like these aspects of reality By a continuance of such processes the idea of its own mind as something private and intimate, of its body as less private, grows up, but at the same time the notion of its mother as having a body like its own arises, and eventually the belief that its mother's body has mind

It does not seem to me probable that these processes are distinct I do not think that the infant forms an idea of an external body like its mother and then attributes mind to this body All goes on simultaneously But unless in its total reality, all of which is at first equally real, it discriminated both mind and body, it would not conceive of its mother as having mind

Therefore the belief of the infant in reality as a whole is, as Spinoza said, an instinctive belief Its beliefs in mind and body are interdependent, not self-conscious, inductions from experience, unless both inductions were made, neither would hold Our belief in external reality is thus a threefold affair an instinctive belief that all experience is real, a belief in minds which depends on a belief in bodies, a belief in bodies which depends on a belief in minds

So my knowledge of your mind, both genetically and actually,

is derived from knowledge of your body. We have reached a curious stage in our proceedings. The real material world is a certain kind of ideas common to you and me; but I know you through your body. "Why do I postulate your mind? Because I see your body acting in a certain way. Its gestures, facial movements, words and conduct generally, are 'expressive'; so I deem it actuated as my own is, by an inner life like mine. This argument from analogy is my *reason*, whether an instinctive belief runs before it or not." [1]

Belief in the external objective world depends on belief in other minds, and belief in other minds depends on belief in the external world.[2] This account of our belief in objective reality, then, assumes other minds. But, these assumed, if knowledge is possible, then minds have common objects; which means that this idea of a chair that is in my mind is also in yours, that our ideas are conterminous, that my mind is part of your mind and your mind part of mine, and that the object also exists and is like my idea. The world thus becomes a mental world in which certain ideas belong to you and to me and to an object. Such ideas are what we mean by material existence. Before such a conception can be made to appear more than a mere assertion we must show (1) that the world is mental, (2) that minds exist, and (3) that objects exist which are actually *mental* existences.

This account of the psychology of our belief in reality, and especially in external reality, calls attention to several points I wish to emphasize. In one sense all must agree that my knowledge of reality is given in ideas. But, looking at ideas, we see that they differ, as in general imaginary fires differ from real fires. When we ask what the distinction is we come to difficulties. There is no intrinsic mark in the ideas themselves which serves in all cases to distinguish one kind of idea from another;

[1] James, *Essays in Radical Empiricism*, pp. 77–78.
[2] For a different and suggestive account of the relations between minds, see C. Delisle Burns, *The Contact between Minds*, 1923.

it is by a general induction from experience that we build up a conception of certain of these ideas as being more real than others. The chief grounds for this induction are that some of our ideas are permanent and bebave in a different way from other ideas and apparently are common property. When one asks bow it is known that any ideas are permanent and common property, there is no answer. Yet we believe in their reality, as Spinoza says, because there is nothing to prevent it.

I have insisted on this psychological analysis because I think it shows how our belief in external reality and in material reality is actually built up, and because it sbows that, psychologically at least, this belief is an induction from experience and bas no *a priori* validity. Now I want to go a step further and assert that this is all the validity it has; to affirm that wbat is given in experience is ideas; to maintain that by reflecting on experience we may form a theory to explain it, but tbat tbe test of this theory is that it makes experience more intelligible. We cannot get outside of experience in order to compare it with our idea and determine whether the idea is false or true. So our belief in an external world is necessarily arguing in a circle. Starting with experience, we get back to experience. We can show what experience probably is; we cannot prove that the probability is true. All this is what Dr. Santayana calls a "malicious" psychology. It is done with a purpose, which is to assert that this psychological analysis is the truth about reality.

That this account is true rests on another assertion for which we must give reasons, — that a non-mental world is unintelligible. We must, moreover, give reasons for the assumption that other minds and objects exist. The grounds for these statements will gradually appear; at present, if we accept Berkeley's position, we are shut up in our own minds. But "the incredibility of such a philosophy is flagrant. It is 'cold, strained, and

unnatural' in a supreme degree; and it may be doubted whether even Berkeley himself, who took it so religiously, really believed, when walking through the streets of London, that his spirit and the spirits of his fellow wayfarers had absolutely different towns in view." [1]

[1] James, *Essays in Radical Empiricism*, p. 77.

CHAPTER VI

THE ESCAPE FROM SOLIPSISM

The Absolute

When one seeks logical, *a priori* reasons for rejecting the results of Berkeley's criticism, which lead to absolute scepticism, one encounters difficulties. Bishop Berkeley escaped by holding that these ideas which we believe represent reality are caused in us by the act of God. Of course this is a possible hypothesis regarded merely as the source of ideas. It does not, however, prove that my own mind may not be the cause of these ideas and, so far as I can see, Berkeley does not furnish such proof. Josiah Royce thought he had found a solution. He agrees that some such psychological account of our belief in the external world as we have been considering is true so far as it goes; but he believes that my private thought implies an objective reality other than my individual mind. Reality independent of any mind is inconceivable, is meaningless. All knowledge is knowledge of ideas; yet the very possibility of doubting whether truth and error exist makes it necessary for my mind to hold the idea of an inclusive thought, the absolute, which thinks all reality. Reality is mental; but it is not my private mentality, so to speak, and therefore it is not solipsistic. The absolute is the sole real, objective fact. The reasons for this conclusion are given in the very nature of truth, to an examination of which we must now turn.

The first point to be noticed is that the idea of truth presupposes an idea and an object; if the idea is true, it must in so far as true be identical with the object. For example, I have an idea of a chair. If this idea is a true one, it must represent what

the chair is. If the chair really has parts, my idea of it must represent these parts; if it is in space and time, my idea of it must contain these spatial and temporal aspects. A second aspect of our conception of truth is that when I have the idea of a chair I mean a certain kind of object. By experience I can test this meaning and find out whether there is anything that corresponds to my idea. But the test is that experience does furnish further ideas which fulfil and correspond with my intended meaning.[1] A third aspect is that mere correspondence of ideas is not enough. My idea of the chair must point to, must mean, the actual chair, the actual chair being merely, so far as we have seen, the fact that ideas like our original meaning actually do appear. That mere correspondence is not enough is shown by the following example. Suppose identical twins. If they are identical in every particular, then their ideas will correspond; but the mere fact that they have the same ideas does not signify that the ideas are true. If truth is to have any significance the idea must mean a definite object.

My idea, then, means an object; experience furnishes the fulfilment of this meaning in the shape of ideas; thought recognizes that the meaning is fulfilled by experience and says that my thought is true. So truth implies a thought which shall include both the object and my subjective meaning and shall recognize that they correspond. All these terms, however, are mental terms and necessarily so, for the meaning of truth can be defined only in mental terms. Accepting this general account of truth, let us apply it to the world of physics, which supposes that the desk on which I write is not precisely what it appears to be but in reality is composed of electrons that do not depend on my thought of them or on any thought, that are non-mental,

[1] This is not intended to imply that symbolic knowledge—thought without explicit imagery—is impossible. The symbol does not give the whole truth, however.

independent material existences, but nevertheless are objects of knowledge. In other words, physical realism asserts that, even if *all* mental existences vanish, reality will still exist. Royce and Berkeley hold that knowledge is not possible in such a world and that therefore such a world cannot be reality.

What apparently occurs is this. I have an idea which holds that the table is electrons. To know that this idea is true, I must have an idea which includes both the object (the electrons) and my idea of it, and recognizes that the meaning and the fulfilment correspond. But this inclusive idea is again my own idea, and another idea is necessary to include the inclusive idea and the electrons; therefore we are involved in an infinite regress that can never give knowledge, that never reaches the electrons. The result of such reasoning would be that no knowledge is possible, for we never should reach an inclusive thought. Various conclusions may be drawn from this predicament. Mr. Bradley's solution is that any statement made in relational form can apply only to appearances, so that knowledge exists only for the absolute, which swallows up all relations; therefore all phenomena occur in relational form, and all relational thought gives us knowledge of appearances only, since all such relational form involves a pernicious infinite regress which is unintelligible.

Royce, however, reaches a somewhat different conclusion. While holding that a world independent of mind is unintelligible for the reasons pointed out, he believes, nevertheless, that we can see how knowledge is possible. Truth means that an idea which I have and which expresses my meaning is found to conform to a further unfolding of my inner experience. If I say that oxygen and hydrogen form water, I mean that I believe, or will, that the world of experience is thus constituted; I have an idea which I affirm. Now if future experience, which of course consists of other ideas, fulfils this assertion, then my idea is verified, is true. But I also have an idea that any statement I make, any

purpose my will affirms, is either true or false, will be verified by experience or will not be verified. I have, then, in my own mind an idea of an absolute measure of truth and error, although being finite, any individual opinion I may hold may be true or false. I have in my mind the idea of the absolute. I am part of the absolute, for this is involved in the bare possibility of error. So for Royce the world is the mind of God, which I know because I am part of the mind of God and which I do not know completely because I am finite. My existence is not independent of God nor is his of me, for we are essentially one. The reality of the diversity of the world, of the many electrons, minds, or whatever, has vanished. The world is one; it can be conceived merely as an absolute mind that thinks the world of which I and my consciousness are a part. The reality of my individual loves, fears, purposes, is, however, lost; I am swallowed by the absolute. But a horrible thought arises. According to Royce, the very idea of the absolute is an idea in my finite mind. How can I feel sure that the world is more than my individual dream? Does this idea that my present meaning will either be fulfilled by experience or will not be so fulfilled mean more than that it will be fulfilled by my individual dream? Is the world more than the mere succession of my dreams? And here again we are faced by the spectre of solipsism.

In other words, Royce says: Doubt as much as you like; assert that all is a dream, that truth and error do not exist; yet from the very nature of truth you imply that an inclusive thought must exist which thinks all experience and can compare your statement with reality and recognize whether it is true or false. And this, indeed, is true of all possible statements, of all possible experience. The absolute idea exists. But see, this absolute is in a sense present to my consciousness, it is my deeper self; I am at least a part of the absolute, but not all, since my knowledge is only finite. The absolute is the basis of

all possible experience; it is the all-embracing thought which is the standard of truth, which fulfils my meaning and includes both my meaning and the truth and error of my meaning. Yet, admitting all this, the idea of the absolute is still my idea, my idea of the absolute may be the only absolute that exists; so as yet we have not escaped from solipsism. Moreover, we have apparently not yet attained knowledge of any reality, for Mr. Bradley denies that Royce's internal relation of thought to thought gives such knowledge, and we have just seen that it furnishes no escape from solipsism. But we have reached the conclusion that in a world where we can attain truth reality must be mental, for knowledge of reality existing independent of mind is unintelligible, involving a pernicious infinite regress.

Now, Royce says in certain passages: "*If* the external world is in itself mental, then, be this reality a standard and universal thought, or a mass of little atomic minds constituting the various particles of matter, in any case one can comprehend what it is, and will have at the same time to submit to its stubborn authority as the lover accepts the reality of the maiden's moods. . . . The real world must be a mind, or else a group of minds." [1] Here in the conception of a plurality of minds I think we shall find our answer. But before taking up this discussion let us get rid of absolutism once for all.

So far as an escape from solipsism is concerned, absolute idealism fails as an *a priori* demonstrable fact. There is another objection to it that is fatal—it does not explain the world as we find it because it does not explain evil. William James once said, either in a lecture or in conversation, that a world in which a roach dies cherishing an unrequited love is not strictly a moral world. But more striking examples of the immorality of the world are evident; indeed, nature does not seem even intelligent. Millions of spores and seeds are produced which never germi-

[1] Royce, *The Spirit of Modern Philosophy*, 1892, pp. 362, 368.

nate; countless spermatozoa and ova are formed which perish. Thus potential human minds are destroyed by wholesale. The rabbit feeds on herbs, the weasel on the rabbit, and it will often destroy for the mere joy of killing; the owl kills the weasel and man kills the owl, and the World War shows to what an extent man will go in exterminating his fellows for his own selfish ends. Looked at from this point of view, the world seems a wreathing, writhing, reeking mass of conflicting wills, stupid in its waste, wicked in its indifference to suffering. "Beauty and hideousness, love and cruelty, life and death keep house together in indissoluble partnership; and there gradually steals over us, instead of the old warm notion of a man-loving Deity, that of an awful power that neither hates nor loves, but rolls all things together meaninglessly to a common doom. . . . Visible nature is all plasticity and indifference, — a moral multiverse, as one might call it, and not a moral universe. To such a harlot we owe no allegiance; with her as a whole we can establish no moral communion."[1]

The absolute, or God conceived as the absolute, is supposed to make all these stupendous stupidities and wickednesses, if rightly viewed, into a highest good. The absolute by its thought produces us and makes us suffer; thus from the absolute point of view suffering and evil are good. "It introduces a speculative 'problem of evil' namely, and leaves us wondering why the perfection of the absolute should require just such particular hideous forms of life as darken the day for our human imaginations. If they were forced on it by something alien, and to 'overcome' them the absolute had still to keep hold of them, we could understand its feeling of triumph, though we, so far as we were ourselves among the elements overcome, could acquiesce but sullenly in the resultant situation, and would never just

[1] James, *The Will to Believe*, etc., 1897, pp. 41-44. (Quoted by courtesy of Messrs. Longmans, Green, and Company, New York.)

have chosen it as the most rational one conceivable. But the absolute is represented as a being without environment, upon which nothing alien can be forced, and which has spontaneously chosen from within to give itself the spectacle of all that evil rather than a spectacle with less evil in it. Its perfection is represented as the source of things, and yet the first effect of that perfection is the tremendous imperfection of all finite experience. In whatever sense the word 'rationality' may be taken, it is vain to contend that the impression made on our finite minds by such a way of representing things is altogether rational. Theologians have felt its irrationality acutely, and the 'fall,' the predestination, and the election which the situation involves have given them more trouble than anything else in their attempt to pantheize Christianity. The whole business remains a puzzle, both intellectually and morally." [1]

There is, of course, a view of nature that gives rise to a very different vision, to a vision which was essentially that of William James when he was not fighting the absolute. Go, on some calm, cool morning just at sunrise, to the border of the lake on which your camp is placed. The forest is resplendent in autumn glory, every bush glows with color, the greens of the spruce and hackmatack enhance the crimson and gold and mauve and purple of the maple, oak, and alder; every twig has its dewdrop, catching a ray of light from the infinite and transforming it into a jewel, sometimes more austere than the diamond, often more passionate than the ruby, and again more serene than the emerald. And this picture is duplicated in the bosom of the lake, broken only when a trout, radiant in the morning light, disturbs the tranquillity for a moment. And if you are fortunate

[1] James, *A Pluralistic Universe*, 1910, pp. 117–118 (by courtesy of Messrs. Longmans, Green, and Company). Cf. A. G. Heath, *The Moral and Social Significance of the Conception of Personality*, 1921, especially pp. 26–53. For a defence of the absolute, see W. E. Hocking, *The Meaning of God in Human Experience*, 1912, especially ch. xiv.

you will see a doe emerge with her fawn, and you will see mother-love in all its beauty; and if you look down you will see a society of ants, and you will hear the bees on their errands, and the family of rabbits will whisk about you, and some bird may celebrate the new day. And if you are not all mere electrons you will be filled with "the peace which passeth all understanding." Then, if you reflect, you will see that this is the vision of nature you should cherish, this is the vision it is your task to make actual; and you will never rest until you get some intellectual insight into the way this can be done, some insight into the reality that makes such a vision possible. And if, when you have such insight even most imperfectly, you look at the most sordid and commonplace objects, a telephone-pole, the garbage-man at work, you will again see your vision; you will see that the understanding and valuation of these objects imply an estimate of the meaning of the whole universe and your place in it; and in spite of the cruelty and stupidity in experience you will hold to your vision and fight for something better.

The notion of an absolute, then, gives rise to a problem of evil to which there is no answer. But if you suppose that the world is a community of spirits, with a merciful, loving, but limited God at its head (if you deem this necessary), then evil becomes not an unintelligible, unknowable mystery but something definite to be fought by God and man and to be conquered. The world becomes a striving of all sorts and degrees of wills to do something. Neither God nor man nor animal nor plant has solved the mystery; all are working it out. Mistakes, stupidities, wickednesses naturally result, but not of necessity; conceivably they all may be overcome. And now let us leave the absolute.

But we are still left tied up in our own minds, for the absolute does not furnish a rational escape from solipsism. Through our attempts to show that the world is mental it has become too

mental; it is all our own private idea, and, according to Mr. Bradley, even private ideas seem to be in a self-contradictory tangle. But we have pretty effectually got rid of the physical world in so far as it is conceived as non-mental: (1) such a conception is not proved by the argument from continuity, for this cuts both ways; all depends on what you assume at the start; (2) it fails to explain how the mental can rise from the non-mental, from the material,—an absurd conception; (3) it fails to account for the existence of knowledge, for in such a world knowledge is not possible.

I think the answer to our problem was very near to Royce's mind, but his Calvinistic prejudice, correctly pointed out by Dr. Santayana in his somewhat unkind and unjust account of Royce's life and philosophy,[1] prevented him from using it and drove him to the absolute. As we have seen, Royce says the assertion that the world is mental means that reality is composed of a mind or of minds; and with this we can agree. So our problem changes form at this point and becomes that of finding reasons for holding that reality is to be conceived in a pluralistic form, of furnishing some proof that other minds exist. Now, I do not think that absolute proof of the existence of other minds can be given, but I do believe there are reasons which make it extremely probable that minds do exist. The criticism of the idealistic theory by the neo-realists will aid us in this quest.

[1] George Santayana, *Character and Opinion in the United States*, 1920.

CHAPTER VII

THE ESCAPE FROM SOLIPSISM

Pluralism

In order to understand the significance of the criticism by the neo-realists, it is necessary to keep in mind the essentials of our theory as to the meaning of truth and to amplify it in some respects. The result we have thus far reached is that knowledge is a special relation between idea and object and implies that the idea and the object are identical in so far as truth results. For us, idea and object are both ideas in a mind, since truth is the fulfilment of an ideal meaning. This theory rests on the assumption that truth is given in experience, an assumption which has a large degree of probability, since science does enable us to control experience in a surprising degree. Moreover, all constructive theories about experience involve the assumption that there is truth. The proposition that truth consists in the internal meaning of ideas rests on Berkeley's observations, and on the criticism of Mr. Bradley and of Royce that an external relation between idea and object is unintelligible since it leads to a harmful infinite regress.

Before going further we must supplement this account of truth in certain respects. When we ask what is the test of truth, we are forced to admit that it is always that of experience. Thus the Newtonian laws were conceived as a framework for experience; they were held to be adequate and universally true, and experience shows that in very many respects these laws work. But certain experiences do not fall in with the Newtonian hypothesis, — for such it actually is, — among others the measurement of the velocity of light, the behavior of planets, and the

path of rays of light as observed in solar eclipses. Experience, in the form of certain physical experiments, thus forces a revision of the Newtonian hypothesis. It is in part true, holding for motions not approximating the velocity of light; but it is not absolutely true. The test of truth is that it explains experience. But again experience must be taken in a wide sense.

You will remember that Spinoza said we believe any idea is real unless something prevents us. Now, a part of experience is that a concept cannot be believed if it is seen to contain a meaning that is self-contradictory. Inner consistency must, then, be part of the pragmatic test of truth.

But our account is still incomplete. Suppose we assert that it is true of nature that she obeys mechanical laws. We are regarding nature from one point of view, and from that point of view the proposition is probably true. Suppose we next assert that the world is such that ideals of goodness and beauty are effective. This is an assertion that introduces different standards from the mechanical; it introduces values. The proposition is, however, either true or false of reality as it actually is. But if ideals are thus operative the assertion that nature is mechanical is not wholly true. It is necessary, therefore, in judging the truth or falsity of a proposition to take account of the point of view, to ask whether our point of view includes all reality or only a part. Thus it is possible to assert that there are in a sense different grades of truth, some more inclusive than others. An idea to be true must, then, be adequate; and an idea may be adequate for one purpose but not for another. The Newtonian laws may be adequate to express motions of bodies under certain conditions, and in so far as that is all I mean by them they are true. If I assert that they describe all motions, it may be that they are inadequate and must be supplemented; the adequacy of the idea depends on my point of view, my meaning at the moment. If I look at a sunset and say it is beautiful, this assertion also is

in a sense either true or false; it implies that for a certain point of view the object fulfils the ideal meaning. But the point of view is a different one from that in which I assert that the sunset is a vapor which transmits rays of light from the sun in various ways. It would therefore appear that there are different grades of truth, and that the highest truth attainable would be that which includes all reality in one harmonious, intelligible statement and which combines all possible points of view. [1]

Moreover, it appears very probable that an idea might adequately represent experience at one time and not at another. If you make the assertion that man existed in the Cambrian period, your remark is not true; but it is true that man existed in the year A.D. 1923. So in some sense the objective reality which is the test of truth changes and develops. The standard of truth is, then, ever changing. That this is so is of course disputed. It is held absurd to maintain that truth is possible unless there is some absolute standard which tests the validity of any proposition and is independent of time. But as a practical test a moving, dynamic standard is just as good as any other; it is merely a question for experience to decide whether new facts do come into the world in the course of history or not. If nothing new appears, then no true evolution is possible, no change occurs. The world at any instant of time is just what it was at any previous instant of time. Such a conception is to me inconceivable, it does not fit the facts. It is the absolute again. It affirms that all we observe is appearance, illusion, that only the unchangeable is true. Therefore I think, if change is real, we must suppose that what is truth at one moment is not necessarily truth at another moment, although this does not necessarily imply that no statement about reality can be more than temporarily true. For example, it may be that the proposition, reality

[1] F. H. Bradley, *Appearance and Reality*, 1893, ch. xxiv; Viscount Haldane, *The Reign of Relativity*, 1921, pp. 10–15.

is a community of spirits that continuously produce new relations in the world, is absolutely and eternally true. Nevertheless, any specific assertion about what relations actually exist at the moment would be true only for that moment. Hence it seems wisest to say that, although there is possibly a proposition about reality which must be either true or false apart from any temporal aspect, yet empirically it seems probable that this must describe reality as in a state of change. The objective standard must, then, be regarded as a reality that is continuously creating something new. Truth is defined by an objective standard, but the standard is not a fixed and completed one.

That mental activity does create new objects is just the kind of theory we are advocating; for if one builds a house, if one invades the Ruhr, if one establishes Sovietism in Russia, a new object is made and is apparently accomplished by the activity of purpose. But, if I have merely a vision of bringing about social reform and have not yet found the means, my purpose, however clear, is not actual; it has caused no change, no new object exists. Activity of thought does not give objective truth in itself, but by creating new objective relations it gives a measure of truth to which our internal meaning may be referred.

Thus the pragmatic test of truth is accepted, the creative activity of thought is assumed,— indeed, any theory of reality must assume some kind of creative activity, — the essential identity of idea and object is maintained, and an objective standard to which ideas refer is held to be implied in the very meaning of truth, degrees of which are recognized. But this objective standard is described as exhibiting a process of development through the activity of thought. The theory that truth is merely the subjective feeling of satisfaction is, however, rejected.

Now, the assertions that knowledge is possible, that there is

some object other than my individual thought, that idea and object are essentially of the same stuff, are fundamentals underlying the theories of knowledge that are implicit in the view of common sense, of orthodox physics, of the speculative physics of Dr. Whitehead and Mr. Alexander, of the radical empiricism of James, the objective absolute idealism of Royce, the critical realism of Dr. Santayana.[1] Idealism asserts that the only conceivable real relations are mental relations. On the other hand, realism, old and new, affirms that a variety of other relations than this are possible and actual.

The argument of the neo-realists, as I understand it, is as follows. Experience gives us elements. "The elements themselves, the 'materia prima' or 'stuff of pure experience,' are neither psychical nor physical. A certain spatial and dynamic system of such elements constitutes physical nature; taken in other relations they constitute 'ideal' systems, such as logic and mathematics; while in still another grouping, and in a specific functional relation, they make up that process of reflective thought which is the subject under discussion in the author's theory of ideas and of truth."[2] Thus it is held possible to conceive of the "elements" as being in relation to my mind, to your mind, to an absolute mind, and out of relation to any mind, that is, as existing in physical relation to each other. Now, this is a question of fact,—can a knowable reality be intelligibly conceived as having relations of its own external to any mind? As Dr. Perry well says, "The theory of the externality of relations is not sufficient in itself to establish the case for realism. Indeed it is so general in scope as to argue pluralism rather than realism. . . . But it remains for realism to investigate the precise nature of the relation of things to consciousness, to dis-

[1] Cf. R. B. Perry, *Present Philosophical Tendencies*, 1912, pp. 124-126, 306-313, and note 2 on p. 313.

[2] *Ibid.*, p. 353. (Quoted by courtesy of Messrs. Longmans, Green, and Company, New York.)

cover whether or not this is a relation of dependence."[1] And of course this is the problem for idealism too.

The answer to the question, I believe, is as follows. Realism is right in assuming that ideas, or "elements of experience," may exist in plural relations; but the recognition of plural relations as actual does not depend on the theory of external relations. Thus the chair, whatever its reality, may be conceived as having a relation to my mind, to your mind, to other objects, to the floor. It is merely a question as to the kind of relations we can conceive. Realism holds that we can conceive of external physical relations between "elements," and of an external relation given in knowledge when something is added to the "elements," so that one element becomes idea knowing object. But this is precisely what idealism denies. It does not necessarily deny that "elements" may be in relation to a plurality of minds, although some idealism, as Royce's, does deny this. But it does deny that these plural relations, in so far as they are objects of knowledge, can be conceived otherwise than as internal mental relations. The reason why idealism holds that external relations do not form a part of reality is because they do not lead to knowledge but involve an infinite regress which never reaches knowledge. Thus, if you take any of the external relations of "elements," such as cause and effect, you become involved in an infinite regress, you can never reach the first cause; your relations do not explain. Mr. Bradley insists, and I think with reason, that all external relations are of this order, even such a one as an added relation to "elements," which, realism asserts, gives knowledge.[2]

Mr. Bradley goes even further and maintains that any form of thought conceived as relations between terms, even such a relation as thought meaning another thought, involves likewise

[1] R. B. Perry, *Present Philosophical Tendencies*, p. 320.
[2] F. H. Bradley, *Appearance and Reality*, chs i–xii.

a harmful infinite regress.[1] The conclusion to be drawn from such a contention is apparently that no knowledge is possible. Such a conclusion, however, seems to me absurd, to be contrary to experience. Of course Mr. Bradley would deny this interpretation of his results and would assert the true conclusion is that real knowledge somehow transcends relational thought, that this means reality must be conceived as essentially one, and can be thought only by an absolute which transcends relations. To use his own words: "And our main result is briefly this. The end, which would satisfy mere truth-seeking, would do so just because it had the features possessed by reality. It would have to be an immediate, self-dependent, all-inclusive individual. But, in reaching this perfection, and in the act of reaching it, thought would lose its own character. Thought does desire such individuality, that is precisely what it aims at. But individuality, on the other hand, cannot be gained while we are confined to relations."[2] Royce and others, especially Mr. Bertrand Russell and Dr. Hocking,[3] have called attention to the fact that a certain kind of infinite regress is intelligible, and that therefore relational thought, if it implies only a certain kind of infinite regress, may and does attain truth about reality, even in relational form. For our purposes, Royce's exposition of what kind of reality relational thought can reach is especially useful.

Royce agrees with Mr. Bradley that such a relation as is ordinarily supposed to exist between subject and object involves a pernicious infinite regress and never does give knowledge. But, if we look at the activity of thought when it puts before

[1] F. H. Bradley, *Appearance and Reality*, ch. xv.

[2] *Ibid.*, p 179. (By courtesy of the joint publishers, George Allen & Unwin, Ltd., London, and The Macmillan Company, New York.)

[3] Royce, *The World and the Individual*, 1908, vol. i, Supplementary Essay; Russell, *The Principles of Mathematics*, 1903, ch. iv, sec. 55, pp. 50–51; W. E. Hocking, *The Meaning of God in Human Experience*, 1912, especially chs. vii–viii.

itself a definite purpose which it wishes to make actual, an intelligible infinite regress is actually observed. Let us suppose that I, a resident of England, have an idea of England which is adequate and which corresponds exactly to all the characters of the real England, if such exists; and let us suppose, further, that I wish to make a map of England, smaller than the real England but one that will represent in every particular the real England. Yet, as soon as my task is completed my map will no longer represent the real England because this England now contains the map; I must therefore make another map showing England with my first map, and so on without end. But this kind of infinite regress is not harmful. I have a perfectly definite idea of what I wish to do, of the way to do it, and of the existing limitations; it is an intelligible infinite regress. Now, the process we observe in the making of the map of England is of the very nature of consciousness, of consciousness schematized, abstracted from nearly all content, yet the essential thing. It is purpose, meaning, which when trying to realize itself splits up into an infinite series that is nevertheless intelligible. This process, a purpose striving to do something, is a thing we can understand and is what is common to all reality. It may be a self-conscious purpose, as when we try to describe the process of thought, or a non-self-conscious process, as when an infant, liking something, says "Oh!," or an amœba merely flows toward a bit of food, or an atom of oxygen combines with hydrogen; but it is always striving to do something which eventually involves an infinite series. So this activity we have observed in the process of intending to make a map is just what self-consciousness is. Here we have a reality existing in terms of inner relations of thought to thought which is wholly intelligible. Therefore, accepting Mr. Bradley's criticism of external relations, I should hold that the kind of relation which is best expressed as a purpose that realizes itself in an infinite series is all that can

be known, — that this activity, which is really consciousness, is what reality is. Contemplating this kind of process, we do reach a reality that we can understand. But we must also accept the contention of the realist that there is no reason why many such realities may not exist, why there may not be many minds; and we should also remember that the relations between minds must not be external relations. Minds, if they are to know each other, must be conterminous with each other. If minds know objects, then objects must be in some sense mental, because only thus can we intelligibly state the relations of objects to minds that know them.

Therefore, in trying to formulate how we can know reality, we find that we can know it only as relations of ideas. But this is a conceivable reality and is of the very nature of consciousness. There is no reason why many such consciousnesses should not exist. We actually believe that they do exist and that objects exist, because this theory explains the behavior of our ideas and because as a matter of fact we believe in all that we have no reason for not believing. But it may be objected that it is impossible to conceive of independent minds, for this involves a relation external to my mind. Such a conclusion is not necessary, for conceivably minds may form part of an organic whole, so that your mind and my mind may overlap. In this case an idea in your mind might well be in mine too. If this idea were also an idea in physical nature, we should have the requisites for knowledge of an external physical world.

Let us now compare our doctrine of truth with this conception of reality. In the first place, our account of reality is consistent with truth defined as the internal meaning of ideas which are verified by experience. Moreover, it makes knowledge possible, because idea and object are identical. It furnishes an objective standard for truth, because the internal meaning of my idea is also an external mental event. It is adequate and comprehen-

sive, because it makes possible the understanding of reality as both purposive activity and physical law and makes intelligible our belief in other minds and in physical objects.

But, when all is said and done, if we have proved anything at all it is merely that the world may be pluralistic and must be mental. For me there is no *a priori* proof or immediate knowledge that minds or objects exist. That they do exist is an empirical theory, — actually we must suppose other minds and objects, otherwise experience is meaningless. Solipsism does not appear to be a fact; for science, by supposing realities at least in part independent of my mind, unifies experience to a very remarkable degree. To be sure, science usually assumes that this reality is of a different nature from mind; but this, we have tried to show, is not conceivable. Therefore I conclude that reality is probably, in a scientific use of the word probability, a community of minds which have different degrees of development. This probability is as great as the probability that certain of our ideas behave in general in accordance with the Newtonian laws of motion; it is as strong as any scientific laws, nay, stronger, for our belief in science depends on our belief in other minds. The reason, then, for our belief in other minds is the pragmatic one that the theory works.

Knowledge is possible in such a world because the chair, your mind, and my mind are conterminous. They are of the same nature as my thought, — purpose splitting up into an infinite series; they are all, when known, parts of my mind, otherwise I could not know them. But they may likewise exist in relation to other minds. Thus the chair may be in relation to your mind but not in relation to mine; it may be in relation to the floor. But again, what constitutes the reality of the chair and the floor and the reality of their relation to each other can only be conceived in mental terms. If this relation of the chair to the floor has any meaning and reality other than a mere relation between

our ideas of these objects, then this relation must be described as a vague, obscure striving of the chair toward the floor. This does not necessarily imply that the chair has a mind, but it does mean that the reality we call the chair may perhaps be described as a definite complexity of mental entities — electrons, if you like, for physics, monads for us—which all have natures similar to our own complex minds. In other words, we must believe in other minds, and we are able to grasp the way in which other minds and objects (which are really mental too) may be known. There is no internal contradiction in such a conception. We have immediate knowledge, however, only of our own ideas, which are not even our own but are a mere meaningless flux.[1] The only intelligible explanation of the behavior of our ideas is that other minds and objects that are also mental form a part of our minds and have their own purposes, which are also represented in our minds.

The advantages of such a theory are apparent. It preserves the reality of objects and other minds, the belief in which no idealistic theory has ever been able to shake. It preserves the idealistic contention that reality can be known only as idea and that the world must be mental. It states intelligibly how knowledge of other minds is possible. It preserves the reality of scientific laws, for these laws are interpreted as the relatively fixed behavior of mental reality. It also preserves the reality of purpose, which is, indeed, the very essence of reality. So Dr. Johnson's reality is there: substance is mental but real, and, while part of the individual thought, is at the same time more than it. Belief in this reality is instinctive and necessary but cannot be proved; yet, since such a theory works and may be stated intelligibly, it is very probable that it is true. Some of the reasons for accepting such a theory I have tried to indicate. My chief point, of course, is that the idealistic point of view

[1] Cf. George Santayana, *Scepticism and Animal Faith*, 1923

includes more of reality and is more harmonious than any form of realism, and in so far as this is so it is more true.

The ultimate test of any theory is that it furnishes an intelligible account of observed phenomena when it is applied to them. That the idealistic theory, interpreted to mean that reality is a community of minds, does do this more satisfactorily than any other theory is the second and perhaps equally important part of my proof. So I shall try to apply it to some realistic theories, to the theory of evolution, and to that of the relation of body and mind. In other words, I wish to test the theory by applying it, by way of criticism, to other beliefs: (1) to the philosophic theories of some realists, (2) to the scientific and philosophic belief in evolution, (3) to the scientific and philosophic theory of the relation of body and mind. Moreover, by the examination of some of these realistic hypotheses we shall glean much that will help give greater concreteness and explicitness to our own theory, now outlined in only its most general form. To begin, let us take the radical empiricism of William James.[1]

[1] An instructive discussion of knowledge and of the function of ideas is to be found in Dr. Hocking's *Meaning of God in Human Experience*, especially chs iv–xii, xvi–xxi, and explanatory note 3.

CHAPTER VIII

REALISTIC THEORIES

Some years ago William James, after mature consideration of the problems arising from the dualism of subject and object, asked the somewhat preposterous question, "Does consciousness exist?" This question is preposterous because in a sense there is no doubt that consciousness exists. One can doubt whether there is given a knowledge of an entity that possesses ideas and has existence apart from ideas. One can doubt whether there is given in reflective thought a self-conscious being who thinks about the meaning of the relation of subject and object. But in the sense that there is a differencc between bcing conscious of a mere bit of immediate experience, of a "That," and of not being so conscious, there is no possibility of doubt. There is a distinction between having experience and not having it. So the question gets pushed farther back: Is "pure" experience conceivable except as a mental experience?

James and others, for instance Dr. Edwin B. Holt and Dr. Ralph Barton Perry, seem at times to affirm that non-mental experience is possible. They believe that in a sense reality is neither mind nor matter, but "neutral," and that the relations between parts of this neutral stuff constitute consciousness. All this is differently described by various authors; but for our immediate purpose it is sufficient to point out that knowledge, the relation of subject and object, consciousness, results from relations between parts of this neutral stuff. So that perhaps what is really meant is that consciousness is derived from a non-conscious stuff by means of a new rclation, that consciousness exists but is not thc ultimate reality. According to this vicw,

knowledge is merely the fact that one kind of neutral aggregate stands in a peculiar relation to another; and these aggregates must be identical, or have identical elements, if knowledge is to result, for a true idea corresponds to its object. The neutral world, then, contains primarily general concepts, like those of mathematics and logic, and qualities like whiteness, which is whiteness whether it is found in snow, linen, or paper. These general concepts have some sort of being which it is difficult for me to describe. They do not exist as objects, they form a class; they float about somewhere as neither mind nor matter but as neutral, like the Platonic ideas.[1] This theory, moreover, asserts that, when the peculiar relation between neutral aggregates appears, knowledge of reality is immediately given.

To be complete this account must, I think, be supplemented, as in fact it is supplemented by some, notably by Dr. Santayana. According to him, there are two kinds of knowledge: the immediate knowledge of awareness, which gives us no knowledge about reality except that there is substance or material; and the more reflective knowledge which begins in perception, when we become conscious of properties that are neutral, that are essences, that are common to you and to me and to the object. This theory has many good points. It shows that reality may exist in other relations than in relation to my own mind; that the stuff which is reality may have relations of its own; in other words, that reality may be pluralistic. It does not deny that the relations of these neutrals, which at any moment may be out of the knowing relation, can at some time enter into such a relation, thus avoiding the difficulty of an unknowable. It also furnishes the beginning of a theory as to what consciousness concretely is. But this description of reality as neutral elements has its own difficulties, as will shortly appear. It will aid us in our discussion to examine a little more closely what conscious-

[1] R. B. Perry, *Present Philosophical Tendencies*, 1912, p. 316.

ness is, according to this theory. A suggestive account is that of Dr. Edwin B. Holt in his *Concept of Consciousness:* —

Mind and matter are not clearly distinguishable; they are both neutral entities. Mind and matter, object and idea, all members of these two classes, "consist of simpler entities — akin to the logical and mathematical entities—so that the substance of the members of these two classes (matter and mind) is the same as the substance of these entities. What this is, is found in the last analysis to be an idle or indeed a meaningless inquiry: these entities do not *have* a substance, they *are* a class. Yet owing to the habit of demanding that everything shall have a substance, an almost insurmountable habit of thought, I have resorted to the merely expository convenience of calling this class a stuff — 'concept-stuff,'" or neutral entities.[1]

This neutral stuff or "mosaic," as Holt calls it, is in a serial order from simple to complex. The most simple neutral entities resemble Platonic ideas; what they are we do not yet know, but they are like the concepts of identity, of difference, of number, and of the negative. Then come algebras, secondary qualities, and intensity, then geometry, and then mass, which is the ratio between the acceleration of two entities. "After mechanics comes physics entire. It was pointed out in a previous chapter that in the concrete, physical objects about us there remains no residue unanalysed into neutral components, such as would have to be called 'Matter.' We now have the same fact from another point of view: various concepts in combination *are* matter."[2] Chemistry comes next. The apparently large number of chemical elements would seem to make impossible a resolution of these elements into more simple terms; but recent investigations, such as those relating to radium, lead us to

[1] Holt, *The Concept of Consciousness*, 1914, pp. 135-136. (Quoted by courtesy of The Macmillan Company, New York.)

[2] *Ibid.*, p. 157.

suspect that the chemical elements "are all definable in terms of small masses arranged as units in various geometrical forms." [1] Even more difficult than the chemical is the transition from inorganic to organic. "In spite of the neo-vitalists, however, it is to-day perfectly clear that life is definable in terms of chemical process; although, confessedly, this definition has not been actually ascertained. Life *is* some sort of chemical process, and nothing further." [2] The next critical place is the emergence of mind. Now, all organisms respond to stimuli; plants, by baro-, helio-, thermo-, chemo-, and galvano-tropisms, respond to certain aspects of their environment. But tropisms are not all; plants respond in some ways like animals, but not of course to spoken words. Plants respond to only a portion of their environment, to a cross-section which becomes actual for them; just as a searchlight on a moving ship illuminates a cross-section or cross-sections of the environment of the ship and makes that actual. In the higher animals response occurs more specifically and in connection with a more highly-organized nervous system, but it is not different in kind.

A cross-section of physical objects reveals neutral entities. The section of a tree cut by a mathematical plane gives a section that can be described by analytic geometry; but such mathematical conceptions are neither in the tree nor in the mind: they are conceptual or neutral.[3] Just so a cross-section of the environment to which a plant responds has neutral aspects, as intensity. Now, grades of intensity are not physical aspects, they are neutral entities, and the directions of light to which plants respond are also neutral entities. The plant's cross-section is a neutral manifold; although the plant organism remains a physical object, its effective environment, indeed its sole environment, is a metaphysical manifold. "This manner in which a cross-section is defined by response, I may say at once,

[1] Holt, *Concept*, p. 158. [2] *Ibid.* [3] *Ibid.*, pp. 178–179.

is my definition of the knowing process." [1] It is consciousness. But immediately the question arises, What is the plant that responds? Dr. Holt says it is a physical object; yes, but physical objects are aggregates of neutral entities. So we really have in knowledge the reaction of aggregates of neutral entities to other neutral entities or aggregates; this reaction is consciousness. In the higher animals and in man this response is the activity of the nervous system, and that is what we mean by our consciousness, that is what gives knowledge. "Elements become mental content *when reacted to in the specific manner characteristic of the central nervous system.*" [2]

Dr. C. A. Strong approached this subject from a different point of view, but he has made an important criticism of the doctrine of neutral entities and of consciousness as an added relation.[3] While maintaining that reality independent of the individual mind actually exists, Dr. Strong holds that the relation of knowing can be conceived only as a relation to mind and not merely as a relation between neutral aggregates. For him, as for Dr. Holt, the response of mind to environment does indeed give the content of experience, but knowledge is a specific relation to which mind is essential; and with this general criticism I understand Mr. Alexander agrees.[4] Dr. Strong goes on to say that consciousness is a natural fact and must come under the law of evolution; materialism does not explain how this is possible. Idealism does not account for the fact that things can exist in countless numbers without being perceived. A non-conscious, extended mind-stuff, not mind-dust, will reconcile all. To account for physics and biology, mind-stuff

[1] Holt, *op. cit.*, p. 179.

[2] R. B. Perry, *Present Philosophical Tendencies*, p. 299. Bertrand Russell, in his *Analysis of Mind*, 1921, seems to accept such a description of mind.

[3] Strong, *The Origin of Consciousness*, 1918; *Why the Mind has a Body*, 1903; *A Theory of Knowledge*, 1923.

[4] S. Alexander, *Space, Time, and Deity*, 1920, ii, 109-115.

must be very minute, and so psychic states must be more complex than is realized. If we examine experience we find mere pains, emotions, sensations; but when we become aware of such facts, are conscious of them as given, a relation becomes evident between what is given and to what it is given. This relation is consciousness. Consciousness, then, is a relation, but it is not one between physical things or between neutral things or between things that have nothing psychic about them. "Givenness" is possible because the psychic is extended and psychic at the same time; it has both psychic essence and physical essence. "Givenness" is a state of our sensibility used as a symbol for an object, and awareness of this process is consciousness. So when awareness arises it always involves a relation of the psychoid to environment, either to its own essence or to another's. Consciousness is an active process and can be defined only in relation to environment; it always contains something acting and something acted on or responded to. Consciousness is not *a* the psychoid or *b* the environment, nor is it merely $a+b$; it is $(a+b)$ in the sense that it is a whole which consists of *a*-reacting-to-*b*. When you ask what reality is, you must assert that it is psychoids which combine to form aggregates. "To sum up the whole matter in two phrases: if the ego were not psychic, nothing would ever be given; and a psychic ego can come by evolution only out of a psychic world."[1] Change ego to thought, and I agree.

There is of course much more contained in all these accounts than I have indicated, but certain aspects are important for our purpose. They all call attention to the fact that what is in my mind may also be in the environment and in your mind; these common elements are called "neutral elements." All the accounts emphasize the fact that consciousness is a response, an

[1] Strong. *The Origin of Consciousness*, p. 322. (By courtesy of The Macmillan Company, New York.)

activity, of something, however described, to a surrounding environment, and that this response is what both constitutes consciousness and gives the content of consciousness. They also point out that this activity is common to at least plants, animals, and man, and must be regarded as a part of all reality if organisms are to be considered as formed from the inorganic. Dr. Strong's criticism is pertinent in that consciousness cannot be conceived as a result from the non-conscious. If the relation of knowing, or rather of awareness, exists at all, it must extend throughout all nature, and this relation cannot be conceived like other relations; it must be of a special sort, it must be a relation of a psychoid. So the apparent result of radical empiricism in this direction would be a pluralism of psychoids that can be described only as minute minds.

But these realistic accounts seem to fail because they do not furnish an adequate theory of knowledge. So far as I can see, they all rest on the assumption that whatever reality is, whether neutral entities, psychoids, or matter, knowledge is something added to this reality, is an external relation. For example, if knowledge is, as Dr. Perry and Dr. Holt affirm, the external relation between neutral aggregates called the nervous system and neutral aggregates called the physical world, no knowledge immediately results; the infinite regress breaks out. If knowledge is given in awareness of psychoid to psychoid, as Dr. Strong holds, we have the same difficulty in another form. Knowledge is impossible unless that which is known has an internal relation to thought in the manner we have attempted to describe.

The critical realists are aware of some of these difficulties. They assert correctly that we must believe in other minds, and they agree that this belief, though perhaps not proved, is supported by evidence so strong that actually no one doubts it; and to this our theory would assent. They also affirm that there is

just as much reason for believing in the existence of objects like chairs, which are independent of mind; and, in a sense, with this we can agree. Experience makes such a belief essential. We interpret the existence of a chair as a mental existence of some sort, which at the same time is part of my mind and yet may exist in relation to other minds and to other objects that are in reality also mental.

The critical realists have a different theory of reality and of knowledge. They hold, as I understand it, that there is mind and that there is other substance; that the mind by "intuition" perceives essences and by awareness knows substance. So that "transitiveness in knowledge has two stages or leaps: the leap of intuition, from the state of the living organism to the consciousness of some essence; and the leap of faith and of action, from the symbol actually given in sense or in thought to some ulterior existing object. . . . It appears from these various considerations that all reasonable human discourse makes realistic assumptions; so that these proofs, as I venture to call them, are necessarily circular: without assuming realism it would be impossible to prove realism or anything else. What I have endeavoured to show is merely that biology, psychology, and logic require and fortify this assumption, not that a person willing to dispense with biology, psychology, and logic need be a realist. You cannot prove realism to a complete sceptic or idealist; but you can show an honest man that he is not a complete sceptic or idealist, but a realist at heart. So long as he is alive his sincere philosophy must fulfil the assumptions of his life and not destroy them."[1] These intuitive essences are reacted to in awareness and are regarded as existing in an object and as having physical being,—as being symbols of something behind them which has them and

[1] George Santayana, "Three Proofs of Realism," in *Essays in Critical Realism*, 1920, pp. 183–184. (By courtesy of The Macmillan Company, New York.)

which acts as if they were embodied in substance. These physical objects, independent of mind and as substance unknowable, are what constitute nature. Nature goes its course according to its own laws. Mind may indeed grasp these laws by becoming conscious of essences, but it has no other relation to nature; it merely contemplates nature, approves or rejects or laughs.

With much of this we can of course agree. We all believe in some reality independent of our own minds and in the possibility of knowledge. Is it necessary or possible to interpret reality as material and as determined by inevitable physical laws? This is just the issue between the kind of realism we have been considering and the idealism our theory supports. If there are other minds and other objects which are indeed mental but real, we have just as much reality in the world as if the objects to which we react were material. A large part, if not all, of this kind of realistic proof only shows that we must believe in a plural world consisting of my mind, your mind, and something called objects. All this, of course, few persons deny. The realistic theory of Dr. Santayana explains little more than mere materialism, for it does not show how mind is evolved nor does it give mind any place in the world. It frankly and necessarily assumes two leaps in knowledge, leaps across chasms the other sides of which are to me invisible. How does the mind intuit essences? how does it ever obtain knowledge of an object? To the latter question we have the answer that it does not. To the former we apparently have the answer that it is an added relation between mind on the one hand and the realm of essences — which is not existent — on the other. Such a conception is open not only to the general criticism of external relations, but also to the difficulty of conceiving of any relation's being added to that which has no existence. The more natural and intelligible solution appears to be to hold that there are ideas, essences and other kinds of

ideas. We are driven to believe in other existences than our bare thought in order to make intelligible the manner in which our ideas behave. We are driven to believe in minds and objects. How can we represent to ourselves any way in which knowledge of these other existences can be given? Now, if they have common characters which are present to me, to the object, and to other minds, then they can be known; but they will be known to me as my ideas which are regarded as having existence at the same time in their object. Their existence in the object is independent of the fact that I know them, but not independent of the fact that they are ideas for some mind. Truth results if the meaning of my idea corresponds to my experience and is fulfilled by it. This experience must be regarded as my idea, but as having existence likewise in other minds, which are indeed a part of my mind and yet to a certain extent independent of it, just as the cells of an organism are parts of the organism and yet to some degree independent of the organism.

So thus far realism has not answered the idealistic objections, but has opened the way to a pluralistic account by pointing out that many minds may exist and that we are forced, if honest, to hold they do exist, and further that objects must be held to exist for reasons similar to those which make us believe in other minds. When we ask what mind is, we find that it is an activity, a response, and that knowledge is a certain sort of relation that can be understood only as a relation of mind. When we look at the evolutionary process and the divisibility of objects, we are forced to regard mind as a minute stuff out of which everything is evolved: substance and mind are identical. We are thus led almost irresistibly to some kind of mind-stuff or mind-dust or monadic theory of reality. Such a theory is, I believe, not the final word; but let us postpone discussion of it for the moment. When we examine how objects may be known and in what intelligible relations they may exist, we are forced to conclude that

they must be mental and must exist in mental relations; otherwise we could not know them as we apparently do, nor could we conceive of their relations to each other and to our minds. There are, however, other realistic theories that attempt from somewhat different points of view to explain reality as independent of all mind. Although all their conclusions are not acceptable, much is to be learned from these realistic systems.

CHAPTER IX

REALISTIC THEORIES (CONTINUED)

THE culmination of much thought on space and time was reached in Einstein's theory of Relativity, which, with the work done before him, has given great impetus to attempts to revise physical concepts. There are certain general results which are of great interest;[1] but, in so far as they attempt to preserve the reality of a world independent of all mind, they are apparently open to our criticism that such a world involves a pernicious infinite regress.

The theory of Relativity is the result of the work of many minds but has been given mathematical form and great precision by Albert Einstein. From certain considerations, chiefly concerning the measurement of the velocity of light, Einstein concludes that we must regard the measurement of physical phenomena as dependent on the position and motion of the observer. So the world becomes a world of four dimensions, time being the fourth dimension. There are, moreover, certain phenomena — for instance, the disturbance in the orbit of the planet Mercury and the behavior of rays of light near the sun — which, it is held, cannot be explained according to the usually accepted geometry and laws of motion. Hence Einstein maintains that, expressed in one way, space is bent or curved, is non-Euclidean, and that the specific form of space depends on the bodies observed, their motions, and the position and motion of the observer. Therefore, although a mathematical statement is possible for the behavior of reality, it gives no description that holds for all spatial and temporal relations; it is a description that any observer may apply, but different specific results are

[1] Viscount Haldane, *The Reign of Relativity*, 1921, pp. 108–118.

obtained in each case.[1] Now, I am not at all certain that this is a fair statement of the theory of Relativity; but, since we are concerned chiefly with certain revisions of various physical concepts formulated by Whitehead, Eddington, and Alexander, controversy about the proper statement of Einstein's theory is of minor importance for our specific purpose.

Whatever may be the result for science, this theory of the relativity of space and time has had the effect of spurring physical mathematicians to very interesting attempts to revise the concepts of physical science. One of the most important and interesting is that of Dr. A. N. Whitehead, expounded in his books *The Principles of Natural Knowledge*, *The Concept of Nature*, and *The Principle of Relativity with Applications to Physical Science.* If the philosophical assumptions on which his theory is founded are valid, then a world like the Mephistophelian world described by Goethe results. It is with great diffidence that I approach the task of criticizing Mr. Whitehead's theory, for such criticism is presumptuous in one without knowledge of mathematics; yet I must make the attempt.

Apart from Dr. Whitehead's mathematical discussions, which form an essential part of his theory, certain philosophical aspects are very important. The inadequate account of this philosophy which I shall attempt to give does not do justice to

[1] A. N. Whitehead, in a discussion on "The Idealistic Interpretation of Einstein's Theory" (Aristotelian Society, *Proceedings*, 1921–1922, p. 132), says: "The relations observed are in every case dependent upon what happens to the body of the observer within nature. All the relations disclosed are relations between natural entities, and the conditions which determine the choice are also particular characters of relations between natural entities." (Quoted by courtesy of Messrs. Williams and Norgate, London.) See also his paper on "The Philosophical Aspects of the Principle of Relativity" (*ibid.*, pp. 215–223), his *Principle of Relativity*, 1922, pp. v, 25–67, and his *Concept of Nature*, 1920, pp. 173–174. Cf. Albert Einstein, *Relativity*, trans. R. W. Lawson, 1920. A. S. Eddington, *Space, Time, and Gravitation*, 1920; Charles Nordmann, *Einstein et l'univers*, 1921; Viscount Haldane, *The Reign of Relativity*, pp. 33–118; "The Einstein Theory," in *The Outline of Science*, ed. J. A. Thomson, 1922, iv, 1023–1042; and C. D. Broad, *Scientific Thought*, 1923, Pt. i.

his views. I have, however, tried to understand them and to state them fairly so far as they concern our present purpose.

Accepting the fact that Einstein and others have forced a revision of our ideas of space and time, Dr. Whitehead wishes to revise the foundations of physics in such a way as to avoid all metaphysical assumptions and especially the difficulties which a dualistic account of nature involves. He accepts Berkeley's criticism and the logical results pointed out by Hume, and asserts that, if one starts from the assumption of a reality which exists in the twofold relation of mind and matter, the logical result is solipsism or worse.[1] He also says that the orthodox description of matter, distributed in different ways at disparate moments of time, is fundamentally inadequate.[2] It is therefore necessary not only to revise physical conceptions so that knowledge is possible, so that time and space are derivative and relational yet real, so that change may be intelligible, but at the same time to formulate an account of nature which is independent of mind and which is a closed system. The fact of knowledge is posited; for nature is significant,[3] and, he says, "I assume it as an axiom, that motion is a physical fact" and "science is not a fairy tale."[4] Knowledge is made possible through awareness, which is apparently a part of nature. Dr. Whitehead specifically declares that his theory is not an attempt to account for all reality, and I constantly feel that he knows more than he has told us. The passages that follow could have been written only by one who has long pondered on fundamental problems.

"The ultimate fact embracing all nature is (in this traditional point of view) a distribution of material throughout all space at a durationless instant of time, and another such ultimate

[1] Whitehead, *The Principle of Relativity*, p 27

[2] *An Enquiry concerning the Principles of Natural Knowledge*, 1919, p. 2

[3] *Ibid*., pp 12, 14, 67, *The Concept of Nature*, pp 4, 107–108, and index

[4] *The Concept of Nature*, p 105 (quoted by courtesy of the University Press, Cambridge, England); *The Principle of Relativity*, p 5

fact will be another distribution of the same material throughout the same space at another durationless instant of time. The difficulties of this extreme statement are evident and were pointed out even in classical times when the concept first took shape. Some modification is evidently necessary. No room has been left for velocity, acceleration, momentum, and kinetic energy, which certainly are essential physical quantities.

"We must therefore in the ultimate fact, beyond which science ceases to analyse, include the notion of a state of change. But a state of change at a durationless instant is a very difficult conception. It is impossible to define velocity without some reference to the past and the future. Thus change is essentially the importation of the past and of the future into the immediate fact embodied in the durationless present instant.

"This conclusion is destructive of the fundamental assumption that the ultimate facts for science are to be found at durationless instants of time." [1]

"What we perceive as present is the vivid fringe of memory tinged with anticipation. This vividness lights up the discriminated field within a duration." [2] "This peculiarity of knowledge is what I call its unexhaustive character. This character may be metaphorically described by the statement that nature as perceived always has a ragged edge. For example, there is a world beyond the room to which our sight is confined known to us as completing the space-relations of the entities discerned within the room. The junction of the interior world of the room with the exterior world beyond is never sharp. Sounds and subtler factors disclosed in sense-awareness float in from the outside."[3]

"The materialistic theory has all the completeness of the

[1] *An Enquiry concerning the Principles of Natural Knowledge*, p. 2. (By courtesy of the University Press, Cambridge.)

[2] *The Concept of Nature*, p. 73.

[3] *Ibid.*, p. 50.

thought of the middle ages, which had a complete answer to everything, be it in heaven or in hell or in nature. There is a trimness about it, with its instantaneous present, its vanished past, its non-existent future, and its inert matter. This trimness is very medieval and ill accords with brute fact.

"The theory which I am urging admits a greater ultimate mystery and a deeper ignorance. The past and the future meet and mingle in the ill-defined present. The passage of nature, which is only another name for the creative force of existence, has no narrow ledge of definite instantaneous present within which to operate. Its operative presence which is now urging nature forward must be sought for throughout the whole, in the remotest past as well as in the narrowest breadth of any present duration. Perhaps also in the unrealised future. Perhaps also in the future which might be as well as the actual future which will be. It is impossible to meditate on time and the mystery of the creative passage of nature without an overwhelming emotion at the limitations of human intelligence." [1]

With this introduction, let us see how Dr. Whitehead solves his difficulties. After stating that Sir J. J. Thomson quotes with approval the aphorism of Poynting, "I have no doubt whatever that our ultimate aim must be to describe the sensible in terms of the sensible," he concludes, "Adherence to this aphorism, sanctioned by the authority of two great English physicists, is the keynote of everything in the following chapters." [2] What the "sensible" is may be determined by an examination of what is given in sense-awareness. "Thought about nature is different from the sense-perception of nature. Hence the fact of sense-perception has an ingredient or factor which is not thought. I call this ingredient sense-awareness. It is indifferent to my

[1] *The Concept of Nature*, p. 73.

[2] *The Principle of Relativity*, p. 5. (By courtesy of the University Press, Cambridge.)

argument whether sense-perception has or has not thought as another ingredient. If sense-perception does not involve thought, then sense-awareness and sense-perception are identical. But the something perceived is perceived as an entity which is the terminus of the sense-awareness, something which for thought is beyond the fact of that sense-awareness. Also the something perceived certainly does not contain other sense-awarenesses which are different from the sense-awareness which is an ingredient in that perception. Accordingly nature as disclosed in sense-perception is self-contained as against sense-awareness, in addition to heing self-contained as against thought. I will also express this self-containedness of nature hy saying that nature is closed to mind." [1]

All experience, then, is not included in this attempt. Mind is not a part of nature as Dr. Whitehead defines naturc; logic, beauty, the good, are not included. Experience as a whole, which may he significant, ideal, is not included. He wishes to examine physical experience, and from the simplest possible elements to erect hy mathematical logic a system which shall he independent of all mind and which will account for nature as defined. The sensible elements, whatever they may he, are given in experience, or at least are abstracted from experience; knowledge is, then, a fact of experience; nature can be known, it is significant. The elements reached are not objects, not atoms, but events; and in the order of events, as I understand it, awareness is included. Nature is always changing, but change is a derivative idea. What really exists is the passage of events, and this involves extension which includes both space and time, or rather which is the foundation of both space and time. Events are the essentials given in experience.

An event may be illustrated by considering some simple physical object. When Sir Ernest Rutherford, in his laboratory,

[1] *The Concept of Nature*, p. 4.

breaks up an element into its parts (electrons), what he ideally experiences is a flash of light. This is, as I understand it, an event, not a physical object.[1] But in this flash are discernible certain elements, characters, which are essential. The flash occurs not as an ideal catastrophe, but overlaps with previous occurrences and with following ones. What is given immediately is not an electron but events which have extension. "What is directly observed is an event. Thus a duration, which is a slab of time with temporal thickness, is the final fact of observation from which moments and configurations are deduced as a limit which is a logical ideal of the exact precision inherent in nature."[2] Events, then, are immediately given by awareness, and from events in the sense that they constitute a reality independent of mind Dr. Whitehead believes that a world of physics which is independent of mind, or at least the framework of such a world, may be constructed.

The method of procedure is as follows: "The second chapter of this book lays down the first principle to be guarded in framing our physical concept. We must avoid vicious bifurcation. Nature is nothing else than the deliverance of sense-awareness. We have no principles whatever to tell us what could stimulate mind towards sense-awareness. Our sole task is to exhibit in one system the characters and inter-relations of all that is observed. Our attitude towards nature is purely 'behaviouristic,' so far as concerns the formulation of physical concepts."[3] Thus Einstein's theory, the Newtonian theory, and in fact any theory are not necessary descriptions of nature but empirical descriptions of the behavior of nature. These theories are all on the same plane: they are investigations into what is actually observed and the test of their truth is that they explain the facts. For

[1] *The Principle of Relativity*, pp. 9, 61–72.
[2] *Ibid.*, p. 7.
[3] *The Concept of Nature*, p. 185.

example, when oxygen and hydrogen are brought together it is an observed fact of experience that water is formed. General laws of the behavior of such phenomena may be stated. These laws serve to unify experience; they are practical laws. So Dr. Whitehead says, "I should be very willing to believe that each permanent space is either uniformly elliptic or uniformly hyperbolic, if any observations are more simply explained by such a hypothesis."[1] It is the pragmatic test that must ultimately decide which theory is true.[2]

It is difficult to criticize such a theory, for to a certain extent Dr. Whitehead disarms one by confining his discussion to a limited part of experience, by disavowing materialism, by asserting that it is impossible to meditate on time and the mystery of the creative process of nature without an overwhelming emotion at the limitations of human intelligence. But there are certain aspects of this theory which we must examine. Three points are especially interesting for us:

(1) The assertion that the laws of science are an attempt to describe the behavior of nature as observed.

(2) The postulate that sense-awareness gives knowledge of a reality independent of all mind.

(3) The opinion that nature shows a mysterious creative process.

To the attempt to describe nature in behavioristic terms by mathematical formulæ there is no possible objection if there is no misunderstanding about what we are doing. Thus the descriptions of Newton, Euler, and Lagrange are one way of so describing nature, those of Einstein another, those of Dr. Whitehead still another. If you admit once for all that there is no inherent necessity about any one of these ways, if mathematics is only a very exact language for describing what we think we observe, there is no objection to using its terms

[1] *The Principle of Relativity*, p. v.

[2] *Ibid.*, pp. 6–7.

Nothing is asserted about the ultimate nature of reality. But science seldom stops here; it usually declares that behind all this we in some way know a reality which gives rise to such laws and from which we can deduce them, a reality which indeed is known as only a part of experience hut as such an important part that if we knew all ahout it we should see that the whole of experience must in some way conform to it. I do not deny that, if we knew enough, a mathematical statement of the behavior of a human being might he formulated, just as a mathematical statement of the way a planet behaves is formulated. But this does not imply anything more than mere bebavior. The planet may move in its orbit hecause angels carry it in just tbat particular fashion; the human body may move as it does because it has a definite purpose. In eitber case behavior could he stated in mathematical terms and would he predictable as long as purpose or any other kind of behavior were constant. Tbe test of whether your account is true or not is pragmatic; if it is found that nature acts in the way described, your laws are true in so far as they apply. But such a behavioristic account, whetber in mathematical terms or not, does not in the least affect either the question of the ultimate nature of reality or the question whether what acts is purpose or mechanism. To quote James: "You see it is the old dispute come hack! Materialism [here Mechanism] and teleology; elementary short-span actions summing themselves 'hlindly' or far foreseen ideals coming with effort into act.

"Naïvely we helieve, and humanly and dramatically we like to believe, that activities both of wider and of narrower span are at work in life together, that both are real, and that the long-span tendencies yoke the others in their service, encouragiog them in the right direction, and damping them when they tend in other ways. But how to represent clearly the *modus operandi* of such steering of small teadencies by large oaes is a problem

which metaphysical thinkers will have to ruminate upon for many years to come. Even if such control should eventually grow clearly picturable, the question how far it is successfully exerted in this actual world can be answered only by investigating the details of fact. No philosophic knowledge of the general nature and constitution of tendencies, or of the relation of larger to smaller ones, can help us to predict which of all the various competing tendencies that interest us in this universe are likeliest to prevail. We know as an empirical fact that far-seeing tendencies often carry out their purpose, but we know also that they are often defeated by the failure of some contemptibly small process on which success depends. A little thrombus in a statesman's meningeal artery will throw an empire out of gear. I can therefore not even hint at any solution of the pragmatic issue. I have only wished to show you that that issue is what gives the real interest to all inquiries into what kinds of activity may be real. Are the forces that really act in the world more foreseeing or more blind?"[1]

If the laws of nature are as assumed by physics, we inevitably reach a point of view like the Mephistophelian description of experience, where purpose, consciousness, is a mere spectator of events. This may be a true interpretation, but it does not meet the demand for a uniformity in experience that shall include purpose, which is just as legitimate a demand as that for uniformity in physical nature; it neglects the empirical fact that purposes do operate and that this fact is just as real and has as much justification as the laws of motion; it fails to account for the creative advance of nature. Moreover, the usual mechanistic theory does not give an adequate account of knowledge: it leaves out the observer. Therefore, since I believe an intelligible statement of the relation of purpose to physical law can be

[1] James, *Essays in Radical Empiricism*, 1912, pp. 179–180. (By courtesy of Messrs. Longmans, Green, and Company, New York.)

formulated, I am compelled to reject Dr. Whitehead's reasoning as furnishing even a beginning on which a philosophy may be built, because he assumes that the short-span activities, the processes of nature, can go on by themselves out of all relation to other activities; and I do this with more assurance because I believe he is building on insecure foundations.

The reason why Dr. Whitehead believes that his account gives a true but incomplete description of reality is because awareness is held to give knowledge of a reality independent of mind. Let us face the issue squarely. If Dr. Whitehead is right, if we have knowledge of extended events in this sense and of necessary causal sequence, then there is little doubt that his uniformity of nature is logically implied. So, granting his premises, formulæ similar to those of Gibbs, which apply to all nature including the bodies of men, are conceivably deducible. All conduct could be ideally reduced to the necessary physical laws of the behavior of whatever science holds to be the ultimate elements; no true science of character would be possible. But knowledge is impossible on such assumptions; and such a philosophy is inadequate, for it gives no account of the relation of the mind of the mathematician to the world he constructs. The whole theory rests on the assertion that awareness gives immediate knowledge of a reality that is independent of awareness. Here knowledge must consist of an external relation between what is aware and the event; but, as we have tried to show, following Berkeley and Royce, such a relation does not result in knowledge but in a pernicious infinite regress.[1] So for me Dr. Whitehead's philosophy is unsatisfactory, for it would separate mind and purpose from nature, thus making impossible an intelligible account of experience as a whole; moreover, it does not

[1] These considerations will also apply to Mr. G. E. Moore's contention in his paper on "The Refutation of Idealism," in *Mind*, new series, xii, 433–453 (Oct., 1903, republished in his *Philosophical Studies*, 1922).

give a satisfactory account of how knowledge is possible, but on the contrary makes knowledge of reality impossible and hence furnishes no foundations for his constructions. Does not bifurcation, a duality of nature, break out again in awareness of events, just as it did in the old materialistic theory which, as Dr. Whitehead himself says, leads to solipsism?

I am aware that Dr. Whitehead explicitly disclaims materialism and the bifurcation of reality. There are many passages like this: "If we are to avoid this unfortunate bifurcation, we must construe our knowledge of the apparent world as being an individual experience of something which is more than personal. Nature is thus a totality including individual experiences, so that we must reject the distinction between nature as it really is and experiences of it which are purely psychological. Our experiences of the apparent world are nature itself."[1] This is very much like the kind of idealism we have tried to defend. In practice, however, Dr. Whitehead bifurcates experience into nature, "the something more than individual experience" that is closed to mind and has its own necessary laws, which are largely those of orthodox physics. Such a bifurcation leads, I think, to all the difficulties of pure materialism.

If, however, Dr. Whitehead would state his theory[2] so as to make all reality mental and the laws of physics the relatively fixed but not necessary laws of the behavior of a certain part of

[1] *The Principle of Relativity*, p. 62.

[2] See his contribution to the discussion on "The Idealistic Interpretation of Einstein's Theory," Aristotelian Society, *Proceedings*, 1921–1922, pp. 130–134; and his paper on "The Philosophical Aspects of the Principle of Relativity," *ibid.*, pp. 215–223. Cf. his contribution to the symposium on "Time, Space, and Material," in *Problems of Science and Philosophy* (Aristotelian Society, *Supplementary Vol. II*, 1919), pp. 44–57. Here Dr. Whitehead apparently approaches more nearly such a point of view as I have advocated, but it is of course possible that I wholly misunderstand him. See also his paper on "Uniformity and Contingency," in the Society's *Proceedings*, 1922–1923, pp. 1–18; and W. Leslie Mackenzie's paper on "What Does Dr. Whitehead Mean by 'Event'?" *ibid.*, pp. 229–244.

reality, these objections would disappear. But the impression I get is that the laws of nature are necessary and invariable and in general are those of orthodox physics, and that nature is not mental but is known in awareness.

Of Mr. Broad's belief, that independent reality is given in tactual awareness, we have already spoken. It is sufficient here to point out that objections similar to those we have noted in regard to Dr. Whitehead's theory also apply to Mr. Broad's independent reality. In a recent book, however, *Scientific Thought* (1923), he has given a much more detailed account of physical reality. Into the details of this I am not prepared to enter, but I think that, in so far as it retains a reality independent of all mind, it is open to the same criticisms that apply to his former exposition.

Of the creative advance of nature Dr. Whitehead unfortunately tells us little. I suppose this creative advance means that, if nature is regarded as a historical process, it shows an advance from the physical to the biological and thence to the mental planes of being. That this is a mysterious process and involves the creation of the new seems apparent. How it occurs is for me the deepest problem of philosophy and one to which we shall soon return.

The problem of stating these relations of the long-span activities to the short-span, of accounting for the relation of mind to reality; of explaining how knowledge is possible, of showing the relations of a reality which has Space-Time relations to what we call mind, has been the task of a very remarkable system of philosophy contained in the two volumes called *Space, Time, and Deity*, by Mr. S. Alexander. For this work I have the greatest admiration and with much of the detail I can agree; but with all my admiration I have the conviction that there is another way of interpreting experience, a way that gives a more adequate account.

Looked at in broad lines, Mr. Alexander's system may be described as an attempt to state all experience in terms of Space-Time. It is the problem of philosophy, as it is of science, to formulate a theory of experience; and, as mind is a part of experience, philosophy must describe mind and its relation to experience as a whole. The logical procedure would be to show how mind results from simpler processes; but for purposes of exposition it is wise to accept a provisional theory of mind from which to set out. Mind is the relation of certain entities to other entities; it is not a unique relation but is a specific complexity of relations found throughout experience. Thus reality in its simplest form is Time related to Space; and in a sense Time is the mind of Space. Knowledge of Space-Time is given through intuition and gives us objective reality independent of mind. The most complex form of Space-Time is neural activity on its objective or contemplated side and mental activity on its subjective or enjoyed side. Mind and body are identical; they both are complexities of Space-Time. Now, the world looked at in this way may be stated either in idealistic or in realistic terms. In its complexity it is something like mind and is the result of an historical development. The whole value of such a description rests on how Space-Time is interpreted.

Mr. Alexander sums up the result of his discussion of the meaning of Space-Time in the following words: "With this clue in our minds we may proceed to discuss the various empirical qualities that characterise existent things at their respective levels, as distinct from the categories. But it will help us to preface the discussion by attempting to sum up in a formula the relations of Space and Time as they have been exhibited in our analysis of Space-Time. The formula may be received as a hypothesis to be judged by its success in unifying the different forms of empirical existence, and it presupposes the conclusions reached in the preceding chapter. It is that Time as a whole and

in its parts bears to Space as a whole and its corresponding parts a relation analogous to the relation of mind to its equivalent bodily or nervous basis; or to put the matter shortly that Time is the mind of Space and Space the body of Time. According to this formula the world as a whole and each of its parts is built on the model with which we are familiar in ourselves as persons, that is as union of mind and body, and in particular as a union of mind and brain. But as this may lead to the misapprehension that we are the standard and exemplar of things, the statement is better made in the reverse and truer form that we are examples of a pattern which is universal and is followed not only by things but by Space-Time itself." [1]

Thus the statement that Time is the mind of Space is not to be taken too literally. It means that Space-Time contains that which, when sufficiently developed, becomes what we call mind; mind is Time, but Time is not yet mind. "In some such fashion as this we may attempt to give fulness and some degree of explicitness and precision to the formula that Time is the mind of Space. There is nothing in the mere hypothesis which is strange or unfamiliar. The conception of a world-soul is an old one. Leibniz once described body as momentary mind, and it is clear from the spirit of our inquiry that for it a point-instant and Space-Time as a whole are 'material' in extended sense of that term. It is more important to explain, or rather to repeat, in what exact sense the formula is used. It does not mean that Time is mind or any lowest degree of mind. I do not mean as Leibniz meant that things on their different levels possess varying degrees of consciousness, from the distinct stage of intelligence down to the confused stage of matter. On the contrary mind is mind and Time is Time. Mind exists only on its own level of existence. I mean that in the matrix of all

[1] S Alexander, *Space, Time, and Deity*, 1920, ii, 38-39. (Quoted by courtesy of The Macmillan Company, New York.)

existence, Space-Time, there is an element Time which performs the same function in respect of the other element Space as mind performs in respect of its bodily equivalent. The points of Space have no consciousness in any shape or form, but their instants perform to them the office of consciousness to our brains. A similar caution will have to be put in presently in respect of the proposition that a point-instant is something material; and because of the danger of misunderstanding, the caution is almost more important than the formula. Our hypothesis is merely that alike in the matrix of finite things and in all finite things there is something of which, on the highest level we know of finite existents, mind is the counterpart or correspondent. So far as the philosopher is concerned with empirical facts, it is his business to indicate what this element is on each level. On the bare level of Space-Time, it is Time. Rather than hold that Time is a form of mind we must say that mind is a form of Time. This second proposition is strictly true. Out of the Time-element, as we shall see, the quality mind as well as all lower empirical qualities emerge, and this quality mind belongs to or corresponds to the configuration of time which enters into the Space-Time configuration which is proper to the level of existence on which mind is found. . . . Still less," adds Mr. Alexander in a footnote, "are minds, as Leibniz thought, monads. The only monads are point-instants. Consequently the monads are not for me minds of a lower order, but they contain an element comparable to mind." [1]

Mr. Alexander's system is really a philosophy of evolution. From Space-Time, which is separable into point-instants, all develops,— categories, matter, all qualities, life, mind, even Deity. Now, I am not clear in what sense point-instants are mental. If they are non-mental, then the system appears to be a refined materialism open to the same objections we have found

[1] S. Alexander, *op. cit.*, pp. 43-44.

in crude materialism; it is difficult to see how mind and knowledge result. If point-instants are mental, then they become little minds or monads of some sort; but Mr. Alexander says he does not mean this. To make the system work, therefore, point-instants must have a different interpretation from that given them by Mr. Alexander; they must become monads. Moreover, by a process of intuition, Space-Time is grasped as extra-mental reality, independent of all mind; but here Dr. Whitehead's bifurcation again appears, with the consequences so often pointed out. Thus this wonderful realistic system appears to be open to the objections already mentioned. It is interesting to note, however, that, by interpreting the meaning of Space-Time so as to make it frankly mental, we may avoid these difficulties.

It is only fair to say that Mr. Alexander believes he avoids asserting that mind is evolved from matter. He escapes the difficulty, after the fashion of Mr. Lloyd Morgan and others, by holding that life is reducible to physical terms, but in the new combination of physical elements called an organism there is an added quality, life; that mind is reducible to terms of life, but again something emerges and is added to the sum of all the physiological elements. It seems to me to be impossible to hold intelligibly that life and consciousness can emerge from that which is not alive and not conscious. But on any theory of evolution one must suppose that, with the emergence of self-consciousness at least, something new is produced which was previously merely implicit. This is really the problem of understanding how anything new can ever come into the world. To this problem we shall return.[1]

Another difficulty appears in Mr. Alexander's description of

[1] But James's words used in a similar connection are always worth quoting: "The fact is that discontinuity comes in if a new nature comes in at all. The *quantity* of the latter is quite immaterial. The girl in 'Midshipman Easy' could not excuse the illegitimacy of her child by saying, 'it was a very small one'" (*Psychology*, 1890, i, 140).

cognition. Knowledge of an object is more than mere response, more than mere "compresence." When I perceive a chair there is compresence of my mind and the object; there is also some kind of reaction; and these two aspects, compresence and reaction, are present throughout observed reality, whether mental or material. But in perception there is a peculiar kind of response. When I perceive a chair I attend to only certain images that are formed. This act of attention is a purposive reaction; it affirms a definite, intended object. Unless this kind of response is common to all nature, to Space-Time, then compresence does not account for cognition. If it is common to all nature, then the world is a mental, not a non-mental, affair. In other words, the ultimate realities are minds.

A third difficulty is the relation of mind and body. Although these are held by Mr. Alexander to be one, yet the relation of the enjoyed aspect of the mind-body to the contemplated aspect seems to be like Spinoza's two attributes of one substance. The contemplated aspect goes on according to physical law; the mind as such merely looks on, merely observes, with the result that we are nothing but conscious automata and purpose is illusion.

Restated in a certain way, Mr. Alexander's type of realism is nearly indistinguishable from the kind of idealism I am advocating. All reality is of one stuff; out of this stuff, which is plural, complexities arise, of which man is the most highly organized; mind and body are one, are merely a complexity of this stuff. Such a view may be described as realism, as idealism, or as neither. If accepted, many differences in the description of ultimate reality disappear, but underneath this possible agreement the old antagonism reappears. For Mr. Alexander, what determines the course of observed nature is necessary law conceived in physical terms. The relation of the quality mind to this physical sequence is that of mere enjoyment; it does not

become plain that mind interferes with this series or can interfere with it. But the world is just as much a mechanism conceived in this way as in the purely materialistic fashion. The emergence of mind is possibly comprehensible, but the activity of mind is either denied or left unexplained. Now, it seems to me that this is the important point at issue: What does mind do in the world? Is it a mere spectator? If it does anything, how does it do it? How can you explain the creative march of nature without some kind of activity? Is not this activity akin to what we are aware of in ourselves? Is it not an observed fact that the physical, the mechanistic, order is broken in body-mind if only by the fact that body acts on mind? So the issue between realism and idealism takes another turn. It is the relation of purpose to law, and this is my most persistent problem. A suggestive contribution is made by Mr. Eddington, one of the most brilliant exponents of the theory of Relativity. His point of view is so interesting that I am going to give at some length his conclusion in regard to the meaning of Relativity:

"We see now that the choice of a permanent substance for the world of perception necessarily carries with it the law of gravitation, all the laws of mechanics, and the introduction of the ordinary space and time of experience. Our whole theory has really been a discussion of the most general way in which permanent substance can be built up out of relations; and it is the mind which, by insisting on regarding only the things that are permanent, has actually imposed these laws on an indifferent world. Nature has had very little to do with the matter; she had to provide a basis—point-events; but practically anything would do for that purpose if the relations were of a reasonable degree of complexity. The relativity theory of physics reduces everything to relations; that is to say, it is structure, not material, which counts. The structure cannot be built up without material; but the nature of the material is of no importance.

We may quote a passage from Bertrand Russell's *Introduction to Mathematical Philosophy*.

"'There has been a great deal of speculation in traditional philosophy which might have been avoided if the importance of structure, and the difficulty of getting behind it, had been realised. For example it is often said that space and time are subjective, but they have objective counterparts; or that phenomena are subjective, but are caused by things in themselves, which must have differences *inter se* corresponding with the differences in the phenomena to which they give rise. Where such hypotheses are made, it is generally supposed that we can know very little about the objective counterparts. In actual fact, however, if the hypotheses as stated were correct, the objective counterparts would form a world having the same structure as the phenomenal world. . . . In short, every proposition having a communicable significance must be true of both worlds or of neither: the only difference must lie in just that essence of individuality which always eludes words and baffles description, but which for that very reason is irrelevant to science.'

"This is how our theory now stands.—We have a world of point-events with their primary interval-relations. Out of these an unlimited number of more complicated relations and qualities can be built up mathematically, describing various features of the state of the world. These exist in nature in the same sense as an unlimited number of walks exist on an open moor. But the existence is, as it were, latent unless someone gives a significance to the walk by following it; and in the same way the existence of any one of these qualities of the world only acquires significance above its fellows, if a mind singles it out for recognition. Mind filters out matter from the meaningless jumble of qualities, as the prism filters out the colours of the rainbow from the chaotic pulsations of white light. Mind exalts the permanent and ignores the transitory; and it appears from the

mathematical study of relations that the only way in which mind can achieve her object is by picking out one particular quality as the permanent substance of the perceptual world, partitioning a perceptual time and space for it to be permanent in, and, as a necessary consequence of this Hobson's choice, the laws of gravitation and mechanics and geometry have to be obeyed. Is it too much to say that mind's search for permanence has created the world of physics? So that the world we perceive around us could scarcely have been other than it is?

"The last sentence possibly goes too far, but it illustrates the direction in which these views are tending. With Weyl's more general theory of interval-relations, the laws of electrodynamics appear in like manner to depend merely on the identification of another permanent thing—electric charge. In this case the identification is due, not to the rudimentary instinct of the savage or the animal, but the more developed reasoning-power of the scientist. But the conclusion is that the whole of those laws of nature which have been woven into a unified scheme—mechanics, gravitation, electrodynamics and optics—have their origin, not in any special mechanism of nature, but in the workings of the mind.

"'Give me matter and motion,' said Descartes, 'and I will construct the universe.' The mind reverses this. 'Give me a world—a world in which there are relations—and I will construct matter and motion.'

"Are there then no genuine laws in the external world? Laws inherent in the substratum of events, which break through into the phenomena otherwise regulated by the despotism of the mind? We cannot foretell what the final answer will be; but, at present, we have to admit that there are laws which appear to have their seat in external nature. The most important of these, if not the only law, is a law of atomicity. Why does that quality of the world which distinguishes matter from emptiness

exist only in certain lumps called atoms or electrons, all of comparable mass? Whence arises this discontinuity? At present, there seems no ground for believing that discontinuity is a law due to the mind; indeed the mind seems rather to take pains to smooth the discontinuities of nature into continuous perception. We can only suppose that there is something in the nature of things that causes this aggregation into atoms. Probably our analysis into point-events is not final; and if it could be pushed further to reach something still more fundamental, then atomicity and the remaining laws of physics would be seen as identities. This indeed is the only kind of explanation that a physicist could accept as ultimate. But this more ultimate analysis stands on a different plane from that by which the point-events were reached. The world *may* be so constituted that the laws of atomicity must necessarily hold; but, so far as the mind is concerned, there seems no reason why it should have been constituted in that way. We can conceive a world constituted otherwise. But our argument hitherto has been that, however the world is constituted, the necessary combinations of things can be found which obey the laws of mechanics, gravitation and electrodynamics, and these combinations are ready to play the part of the world of perception for any mind that is tuned to appreciate them; and further, any world of perception of a different character would be rejected by the mind as unsubstantial.

"If atomicity depends on laws inherent in nature, it seems at first difficult to understand why it should relate to matter especially; since matter is not of any great account in the analytical scheme, and owes its importance to irrelevant considerations introduced by the mind. It has appeared, however, that atomicity is by no means confined to matter and electricity; the quantum, which plays so great a part in recent physics, is apparently an atom of action. So nature cannot be accused of

connivance with mind in singling out matter for special distinction. Action is generally regarded as the most fundamental thing in the real world of physics, although the mind passes it over because of its lack of permanence; and it is vaguely believed that the atomicity of action is the general law, and the appearance of electrons is in some way dependent on this. But the precise formulation of the theory of quanta of action has hitherto baffled physicists.

"There is a striking contrast between the triumph of the scientific mind in formulating the great general scheme of natural laws, nowadays summed up in the principle of least action, and its present defeat by the newly discovered but equally general phenomena depending on the laws of atomicity of quanta. It is too early to cry failure in the latter case; but possibly the contrast is significant. It is one thing for the human mind to extract from the phenomena of nature the laws which it has itself put into them; it may be a far harder thing to extract laws over which it has had no control. It is even possible that laws which have not their origin in the mind may be irrational, and we can never succeed in formulating them. This is, however, only a remote possibility; probably if they were really irrational it would not have been possible to make the limited progress that has been achieved. But if the laws of quanta do indeed differentiate the actual world from other worlds possible to the mind, we may expect the task of formulating them to be far harder than anything yet accomplished by physics.

"The theory of relativity has passed in review the whole subject-matter of physics. It has unified the great laws, which by the precision of their formulation and the exactness of their application have won the proud place in human knowledge which physical science holds to-day. And yet, in regard to the nature of things, this knowledge is only an empty shell—a form of symbols. It is knowledge of structural form, and not knowl-

edge of content. All through the physical world runs that unknown content, which must surely be the stuff of our consciousness. Here is a hint of aspects deep within the world of physics, and yet unattainable by the methods of physics. And, moreover, we have found that where science has progressed the farthest, the mind has but regained from nature that which the mind has put into nature.

"We have found a strange foot-print on the shores of the unknown. We have devised profound theories, one after another, to account for its origin. At last, we have succeeded in reconstructing the creature that made the foot-print. And Lo! it is our own." [1]

Such a view of reality comes very close to the position I have been advocating, providing the absolutely permanent and the necessary are not implied,—namely, reality is mind and the laws of physics are the laws of mind. Of course such a theory is not generally accepted by physicists, but I believe that philosophically it is justified. I have tried to show that reality is mind, which we may if we choose call substance; it is the stuff which acts and out of which all else results. Mind is conceived as the activity or reaction of a part to its environment, but as an activity that splits up into an infinite series which may perhaps be called atoms or electrons. This infinite series is still a whole; but because it is a whole and because each discernible part is a part of the whole, because the parts of reality — minds, monads, or atoms — exist in an organic unity, therefore knowledge is possible. The physical world is a part of reality which is relatively permanent and common property. The laws of this part of reality are the laws that mind is able to construct from observation of the behavior of certain aspects of reality, — the

[1] A. S. Eddington, *Space, Time, and Gravitation*, 1920, pp. 196–201. I do not pretend to understand all of this in detail. (Quoted by courtesy of the University Press, Cambridge, England.)

relatively permanent aspects. But, since what constitutes the given appearance of reality is dependent on the point of view and choice of the observer, any adequate description of reality must be one that takes account of all points of view. For me this would not make the physical the necessary point of view, but only an interesting and significant one. Points of view including values, morality, conduct, would also be necessary.

Such a relatively universal point of view might be stated as follows: Reality is the striving of minds to reach complete knowledge and harmony of purpose. In so far as this striving is relatively fixed and permanent and common property, it is the world of physics. Such a world, however, shows a creative advance which is the purposive, creative activity of mind. Mind, reality, or substance reveals itself in different ways according to the point of view of the observer, who selects what is for him the important condition under which he shall view reality. Thus a rainbow is beautiful color, a mist, or a mass of electrons according to the relations which it bears to the mind of the observer. Which is its reality? All and any. But the important, the significant, one is that set of relative conditions which will best serve ideal purpose. Thus mind actually makes reality in two ways: first, by its creative advance, which produces new conditions; second, by its selection of what is most valuable in its relations to reality. This account of reality, like Mr. Eddington's, holds that all is mind; but the laws of the behavior of reality are not, according to this view, imposed by mind on an indifferent stuff, but each mind finds that its own laws of thinking are in so far as true also the laws of reality.

Such descriptions of reality as we have been considering, whether Mr. Alexander's, Dr. Whitehead's, Mr. Eddington's, or the one I have suggested, are sufficiently removed from the ordinary view of the reality of a chair, and yet in Dr. Johnson's sense they preserve its reality. But there are other interesting

and suggestive accounts of reality that it will be to our advantage to consider.

Dr. George Santayana has long held himself to be a realist in the sense that he believes we must posit a substance independent of mind. His reasons for this we have already mentioned, but they are given more explicitly in his *Scepticism and Animal Faith.* He holds that reflection on experience, if thorough-going, leads to scepticism; but even in this scepticism is discerned, as a necessary foundation for any experience, the fact that the mind knows essences which have being of a sort but do not exist. They are general concepts and qualities like the Platonic ideas, but they do nothing,— they simply are. These essences the mind intuits, and can reason about them and construct dreams of fancy like the efforts of mathematicians. "Pure mathematics consists entirely of such asseverations as that, if such and such a proposition is true of *anything,* then such and such a proposition is true of that thing. It is essential not to discuss whether the first proposition is really true, and not to mention what the anything is of which it is supposed to be true. . . . Thus mathematics may be defined as the subject in which we never know what we are talking about, nor whether what we are saying is true." [1] It is in such a condition that Dr. Santayana is left without his appeal to animal faith, which instinctively, but by a jump, asserts that substance exists. By accident, substance embodies essences which we intuit, so that we are able to arrive at knowledge. But substance acts arbitrarily, and our reasoning about it has no practical results. It goes its own course according to its laws, which we discover because it by chance embodies essences. But in conclusion Dr. Santayana says, "In rising out of passive intuition, I pass, by a vital constitutional necessity, to belief in discourse, in expe-

[1] Bertrand Russell, quoted in Eddington's *Space, Time, and Gravitation,* p. 14, note.

rience, in substance, in truth, and in spirit. All these objects may conceivably be illusory. Belief in them, however, is not grounded on a prior probability, but all judgements of probability are grounded on them. They express a rational instinct or instinctive reason, the waxing faith of an animal living in a world which he can observe and sometimes remodel."[1]

With the position of the sceptic I am in considerable sympathy, and with Dr. Santayana believe that the way out is by a jump. His world of essences has always puzzled me; but after all, if it is easier to conceive the constructive power of the rational imagination as an intuition of a realm of essences, I do not know that it makes much difference. But, when we have, with Plato, once found such a world, it behooves us to show its relations to the real world. The real or existing world is the world of substance, conceived, I suppose, by Dr. Santayana as material. This world by chance embodies essences, so that it is to a certain extent intelligible; but its acts are its own and are irrational and not to be understood; they occur not according to laws of essence but according to their own laws. If we hold, as Dr. Santayana appears to do at times, that essences and reason have naught to do with nature except that nature embodies certain essences, such a view appears consistent. And what else do such passages as these mean? "The life of reason as I conceive it is a mere romance, and the life of nature a mere fable; such pictures have no metaphysical value, even if as sympathetic fictions they had some psychological truth." [2] "Thus the discernment of essence, while confirming Platonic logic in the ideal status which it assigns to the terms of discourse (and discourse includes all that is mental in sensation and perception), destroys the illusions of Platonism, because it shows that es-

[1] George Santayana, *Scepticism and Animal Faith*, 1923, pp. 308–309. (Quoted by courtesy of Charles Scribner's Sons, New York.)

[2] *Ibid.*, p. 101.

sences, being non-existent and omnimodal, can exercise no domination over matter." [1]

Any rational ideal of conduct, then, would either be a contradiction in terms or else inoperative in the physical world, or perhaps both; but his concluding sentences, already quoted, appear to suggest some way out. Until this is furnished, judgment must be suspended. A way out, however, must be found. If nature has produced man, who intuits essences and through animal faith posits substance, can we reasonably suppose that moral faith, that belief in the efficacy of rational ideas, is an illusion? I cannot think so. Therefore, as well as for other reasons indicated previously, I must, until further light is furnished, reject the doctrine as expounded, although I acknowledge sympathy with many statements (I dare not call them opinions) contained in Dr. Santayana's work, as well as a debt for many suggestions not specifically mentioned.

[1] Santayana, *op. cit.*, pp. 79–80

CHAPTER X

REALITY

We have dwelt on these realistic systems at some length, yet not so thoroughly as they deserve. There is much in them that must be preserved; but in one important point they all (with the possible exception of Mr. Eddington's) are inadequate,—by positing a material reality independent of mind they fail to give an intelligible account of reality, provided Berkeley, Bradley, and Royce are right, as I believe they are. But let us turn to the more acceptable task of stating what they positively contribute.

(1) They show that a plurality of minds is a conceivable hypothesis, whereas idealism tends to swallow the individual.

(2) They furnish a beginning for the description of consciousness as an active relation of mind to environment. This, taken with Royce's contribution, gives a broad outline of what consciousness is; but of course the outline is incomplete, since it makes no mention of memory or the power of recognizing similarity and difference.

(3) They recognize the insufficiency of the orthodox physical view of reality, especially the theories of Dr. Whitehead and Mr. Eddington, and point out that nature shows a mysterious creative process which is to be described by the laws of behavior of something.

(4) The test of the truth of these laws is not that they are axiomatic but that nature is found on the whole to obey them.[1]

Our results, then, may be stated as follows: When we try to describe what reality is, we find that it is thought attempting to

[1] This is perhaps not strictly true of these realistic theories; it may be only my interpretation.

fulfil a purpose, an attempt which involves an *infinite* series like Royce's map of England but which is nevertheless an intelligible process. Looked at more closely, this process, this purpose, becomes a response to environment; this environment is my own thought but is also the thought of others. Consciousness is, then, the purposive response of thought to environment; but environment is furnished by other minds which are in part conterminous with mine. This response serves to give content to consciousness, it is Dr. Holt's searchlight; but the mere fact of any kind of response is not consciousness; consciousness is the response of mind.[1] Without purposive response, reality for us is nothing; response or purpose without something to act on is nothing. So the very essence of consciousness is purposive response to environment through which both purpose and content become concrete and actual. Of course consciousness is more than this; but something we have perhaps achieved. Moreover, we have found that the laws of nature are not necessary, *a priori* truths, but are the empirical laws of the more or less fixed behavior of reality. We are forced (by the theory of evolution) to conceive of nature as a creative process. Therefore, before we attempt to complete this schematic account of reality it will be well to return to our object in the physical world and consider it in the light of these general results.

We have seen that physical science holds that a chair is made up of parts which, as methods of observation grow more exact, become smaller and smaller. That parts can be discriminated in reality there seems to be little doubt. We have tried to show that this reality is best conceived as mental. If we attempt to combine these two conclusions, we must assert that reality is a community of minute minds, of minds as minute as are necessary for physics. Any object would thus become an aggregate of such elements; any human mind would be either the fusion of

[1] Cf. S. Alexander, *Space, Time, and Deity*, 1920, ii, 109–115.

a number of such elements or one such element, a soul, in a peculiar relation to other elements. In other words, we have tried to show that the world is a plurality of conscious entities, — minds or thoughts, — and that, since knowledge exists because science gives truth, these conscious entities must know each other; this involves the conclusion that minds or thoughts are conterminous, that they overlap, as it were. We have also seen that there are objects like chairs in the physical world of which we apparently have knowledge, and that these objects are in some sense thoughts. These objects are divisible into parts and these parts are very minute, perhaps electrons. If we accept in a broad way these conclusions, we are forced to regard any physical object, the chair, as composed of mental entities, electrons, — if as such physics eventually describes them, — which largely by laws of their own nature are joined together in the physical object we call a chair. We know this chair because the activities of the electrons are parts of thought, but this is possible only if the electrons are to some extent conterminous with our own minds. Reality, then, would seem to be a community of minds as small and as many as physics deems necessary.

For physics, an individual—you, the reader of this page—is a mass of electrons and nothing else. But for you there exist the thoughts you are now receiving, your own mind. If physics is right, then your mind is the result of the joining of these electrons, which we have described as minute minds, into a whole which is your purposive response to the environment. Thus, to make intelligible the minute realities of physics, you must regard them as monads; and, to preserve the physical description of realities as made up of complexities of these monads, you must think of your mind as an aggregate of monads more or less unified into a whole of some sort. This unity may perhaps be described as the common purpose of all the monads of an organism.

There is nothing new in the theory that physical nature can be understood only in terms of mind; it is the basis of all idealism. Nor is there anything new in the theory that nature is a number of individual, separate minds, a monadology, of which the best-known exponent is Leibniz, with whom Mr. H. Wildon Carr seems largely in agreement. "Leibniz gives us a striking illustration, as remarkable for its scientific anticipation as for its philosophic insight. 'In the smallest particle of matter there is a world of creatures, living beings, entelechies, souls. Each portion of matter may be conceived as like a garden full of plants and like a pond full of fishes. But each branch of every plant, each member of every animal, each drop of its liquid parts is also some such garden or pond. And though the earth and the air which are between the plants of the garden, or the water which is between the fish of the pond, be neither plant nor fish; yet they also contain plants and fishes, but mostly so minute as to be imperceptible to us. Thus there is nothing fallow, nothing sterile, nothing dead in the universe, no chaos, no confusion save in appearance, somewhat as it might appear to be in a pond at a distance, in which one would see a confused movement and, as it were, a swarming of fish in the pond, without separately distinguishing the fish themselves.'" [1] For Leibniz these monads are created by God, and they are related merely because God created a preëstablished harmony so that changes in my mind, in the monad that is me, correspond with changes in other monads. Such a view of the relations of mind is of course not generally accepted. For Mr. Carr, monads are simple substances and as such are not created. They have their own private way of regarding experience— their own perspective. They are the subjects, the minds which act. Everything is a monad that can be conceived as the subject having experience. The

[1] H. W. Carr, *A Theory of Monads*, 1922, p. 23. (Quoted by courtesy of The Macmillan Company, New York.)

subject is closed in its own mind, it is windowless; but, though not communicating or interacting with other monads, they all "mirror" the same universe, which consists of all the other monads; so a natural harmony is established and all monads mirror the same world. Monads as objects of thought, as mirrored, are atoms.

Such forms of the theory of monads seem open to the objection that real knowledge is impossible in such a world. Monads to be known must have an organic connection with my mind. That knowledge is possible, we hold, is implied in the observed fact that the descriptions of science work.

Now, there is the greatest diversity of opinion in regard to the amount of reality and the kind of relation between monads and minds. Thus for Royce individual minds have only phenomenal reality; nature must be described as mind and individual minds are what constitute phenomenal nature; these minds, as indeed human minds, are not reality but are appearances; the absolute mind alone exists. Between these two extreme views—the completely independent minds of Leibniz and the absolute mind of Royce, which appears in nature as minds—there are all kinds of intermediate views illustrated by the opinions of Fechner, Paulsen, Strong, Carr, and Ward. Rather than attempt detailed exposition and criticism of these descriptions, let us consider some of the advantages and disadvantages of such a pluralistic theory as we advocate.

At first sight it seems forced and unnatural to call the electrons minds, it is a difficult conception; yet, if one will try it fairly, it is not so bad. For the very conception of atoms composed of disembodied particles of electricity in rapid motion is not easy, nor is it akin to the common-sense view of reality. Moreover, electrons are not supposed to be completely developed minds like those of human beings; expressed in dualistic terms, electrons have the same relation to human bodies as

monads have to human minds. The electron-monad is a relatively simple, unorganized being; a human mind-body is a relatively complex, organized being. A monad possesses a blind striving like a chemical affinity, and this striving must be vaguely for an end; it may also possess some possibility of being able to store up experience in memory, and likewise some very slight power of discrimination, for it does not seek all kinds of combinations.[1]

But it is nevertheless shocking at first sight to assert that a chair is composed of mental entities. Has a chair, then, consciousness? Not necessarily. It is composed of parts that combine and behave according to their own nature; they show "elective affinities." But whether these units combine into a common consciousness in any given case is a matter to be decided by observation. In the case of the chair they apparently do not so combine; in the case of a human being and of some animals they do seem in some way to give rise to a unified consciousness. How they do this it is difficult to understand. It is also difficult to understand how an organism conceived merely as a physical aggregate is formed by a combination of physical particles. Yet something like this, apparently, actually does occur. So I conceive of my consciousness as made up of that of the monads, or of part of the monads, which make me; my thought has a certain amount of unity; these different thoughts of the monads, then, combine into a whole under certain conditions; this unity is perhaps best described as unity of purpose. When a lot of minds come together for n common purpose and join themselves in a body like a human body, their individual consciousnesses become fused into one. Whether this fusion also occurs in animals, plants, stones, is a matter to be decided by

[1] For an interesting account of the similarity of physical elements to minds, see Clifford H. Farr, "The Mind of the Molecule" in *Atlantic Monthly*, Oct., 1923, pp. 523–533.

observation; and whether human consciousnesses united into a society by common purpose become fused into a higher unity, a social consciousness, a world-mind, which, as Fechner thought, exists as a distinct entity, is likewise a matter for observation. No concrete fact about reality can be determined except by observation of reality.

That so-called inanimate objects may have a certain consciousness has been often asserted, and by some of our best minds. Thus, as Royce says, "we have no right whatever to speak of really unconscious Nature, but only of uncommunicative Nature, or of Nature whose mental processes go on at such different time-rates from ours that we cannot adjust ourselves to a live appreciation of their inward fluency, although our consciousness does make us aware of their presence. And . . . my hypothesis is that, in case of Nature in general, as in case of the particular portions of Nature known as our fellow-men, we are dealing with phenomenal signs of a vast conscious process, whose relation to Time varies vastly, but whose general characters are throughout the same. From this point of view, evolution would be a series of processes suggesting to us various degrees and types of conscious processes. These processes, in case of so-called inorganic matter, are very remote from us; while, in case of the processes which appear to us as the expressive movements of the bodies of our human fellows, they are so near to our own inner processes that we understand what they mean. I suppose, then, that when you deal with Nature, you deal with a vast realm of finite consciousness of which your own is at once a part and an example. All this finite consciousness shares with yours the character of being full of fluent processes whose tendency is twofold,—in one direction towards the formation of relatively stable habits of repetition, in the other direction towards the irrevocable leaving of certain events, situations, and types of experience behind. I suppose that this play

between the irrevocable and the repeated, between habit and novelty, between rhythm and the destruction of rhythm, is everywhere in Nature, as it is in us, something significant, something of interest, something that means a struggle for ideals. I suppose that this something constitutes a process wherein goals, ideals, are sought in a seemingly endless pursuit, and where new realms of sentient experience are constantly coming into view and into relation to former experiences. I suppose that the field of Nature's experience is everywhere leading slowly or rapidly to the differentiation of new types of conscious unity. I suppose that this process goes on with very vast slowness in inorganic Nature, as for instance in the nebulæ, but with great speed in you and me. But, meanwhile, I do not suppose that slowness means a lower type of consciousness." [1]

Personally I should prefer to say that the reality which is the stone exhibits mental traits, must be mental; but whether this bit of reality, stone, nebula, plant, or animal is self-conscious, has a mind that knows itself, depends on conditions that we do not yet know. It may have such consciousness or it may not, but it does not seem probable that the stone has any knowledge of its own existence. From the point of view that a stone is made up of monads that are bits of mind, we can describe it more accurately in some ways. Electrons or monads join into a rough assembly to make the stone, but they do not fuse into a self-conscious mind; in man they do,—why we know not; it is an observed fact. When we say that monads are a convenient but not final description and that reality is a whole in which parts are discriminated, the description of the stone becomes a little more difficult. We must say that a bit of reality which is mental but which is of a very low degree of mentality, which has not learned to react to many stimuli and to store up knowledge and

[1] Royce, *The World and the Individual*, 1908, ii, 225–227. (Quoted by courtesy of The Macmillan Company, New York.)

to reflect, has nevertheless reached a stage where it is not mere chaotic striving like what is apparent in the nebula; that this bit of reality, the stone, is mental, to be sure, is the same kind of thing as our mind but in a very undeveloped form. After all, when one gets accustomed to such a conception, is it any more fantastic than that of science, which considers the reality of the chair to be a mysterious something of which we know nothing but which takes the form of disembodied centres of force, vortices in the ether, electrons, point-instants, or what not?

So provisionally we may say that a lot of minds come together for a common purpose and join themselves in a body like a human body. These individual consciousnesses sometimes become fused into one. Whether this fusion occurs in animals, plants, stones, is a matter to be decided by observation; and whether human consciousnesses united into a society by common purpose become fused into a higher unity, a social consciousness, is also a matter for observation. As we said before, no concrete fact about reality can be determined except by observation of reality.

That minds or mental elements can conceivably fuse in a unity is often denied; it is held that, if these minds actually exist in a conscious body, there must be an arch-mind or monad or soul to receive or mirror their various activities and unite them. The difficulty of conceiving how a soul could unite these disparate elements, and also of stating how the elements could combine themselves, is well illustrated by the different positions that William James has taken at various times in regard to this problem. In his *Psychology* he points out with justice that an evolutionary philosophy is impelled to assert that a human mind is composed of mind-dust, of mental elements which are somehow unified. He holds that it is impossible to conceive of elements as combining, "compounding with themselves," or "integrating," for "*all the 'combinations' which we actually*

know are EFFECTS, *wrought by the units said to be 'combined,* UPON SOME ENTITY OTHER THAN THEMSELVES. Without this feature of a medium or vehicle, the notion of combination has no sense."[1] Therefore many writers have thought it necessary to assert that there is an arch-monad, a soul upon which the elements play and which combines their activities into a whole.

Such a view, indeed, disposes of the difficulty of combination, but is perhaps open to objection. So James, considering all possibilities, was finally driven to assert[2] that, although in the ordinary acceptance of the term logic it is impossible to account for the self-compounding of elements, yet this integrating is an observed fact and can be grasped by non-intellectual methods. Following M. Bergson, he says this process can be comprehended by giving up logic, by getting into life and living it, and thereupon he proceeds to give what seems to me a very logical account of the way mental entities may be said to compound. They form a whole because they were never separated. Let us take a concrete example and suppose we are listening to a concert. The first aspect to be noticed is that there is an impression of unity. The symphony as a whole is a concrete fact; it has a meaning. But those skilled are able to distinguish in this unity the parts contributed by all the different instruments, and even parts in these parts; yet, even while recognizing the parts, they can hear each instrument in relation to the whole. Thus consciousness can change from the discrimination of the particular instruments, with only slight consciousness of their relations to the others, to a consciousness of the unity of the whole with only very slight discrimination of the parts. Yet in each case there is unity and diversity.

Now, this is just what happens in all cases of consciousness.

[1] James, *Psychology,* 1890, i, 158. For full discussion, see the whole chapter.

[2] *A Pluralistic Universe,* 1910, lecture v, "The Compounding of Consciousness."

It is a unity of different elements; my consciousness overlaps with yours and with that of the universe to some slight extent, and can discriminate at one and the same time the unity of this relation and its diversity. The elements of my consciousness overlap likewise and form a unity. Consciousness is this unity in diversity conceived after the analogy of the process involved in making Royce's map of England. Like considerations apply to disparate aspects of consciousness regarded as forming a temporal order. Experience actually does not exist in distinct bits without connection. As Dr. Whitehead shows in his example of the experimental breaking up of an atom, this event is not an isolated catastrophe, but involves a shading of the past into the present and of the present into the future. This process occurs, no matter how complicated the experience. Experience is a continuity in time; not a series of disconnected moments, but a continuity in which parts may be discriminated. Nature, whether conceived as mind or as matter, is not a combination of wholly disparate parts but is a continuity in which parts form a whole. So the question of how elements combine into a whole is really not a proper question. A whole in which parts or aspects may be distinguished is the unanalyzable fact about reality. If we try to go farther and ask what parts or aspects of nature are unified into empirical wholes, and the reason thereof, we find no answer either in material or in mental terms. We can only observe what happens.

As an observed fact, then, we may say that consciousness is a whole composed of parts, somewhat as a human body is a whole made up of parts, the whole being the unified sum of the parts. But, even if this much is agreed upon, it does not solve our entire problem. That a mind is a whole in which there are parts, and that all minds are related parts of the universe and are to some extent conterminous with all other parts, thus forming an organic whole, does not tell us anything about the conditions

under which minds combine into one. Electrons or monads in human beings do seem to constitute one mind, electrons in a chair do not; human minds in a society may or may not give rise to a superior unified consciousness which is more than the sum of the individuals. But some slight conception of the conditions under which this unification occurs may be formulated. In a chair the electrons, if conscious, are concerned not with forming the chair but with merely holding together, each one for itself, as it were. In a human being all the electrons have to some extent a common purpose, they are all striving for one end—to preserve and perfect the particular organization in which they find themselves. This unification of purpose seems to be a condition of the formation of unified consciousness. But such a description would seem to apply to a crystal as well as to a human being. Do both these aggregates have minds? There is no definite proof nor is there any special reason for holding that a crystal has a mind. So the question why monads sometimes combine into a conscious whole and sometimes do not remains unanswered.

I believe that the why of this process, indeed of any process in nature, is unanswerable; in fact, it is possible that such a process is illogical. To illustrate my meaning, let us take the case of the formation of water from oxygen and hydrogen. From the properties of the simple elements it is impossible to predict what the result of their combination will be: water is not merely the sum of the properties of oxygen and hydrogen; something new is produced. We may say, indeed, that under certain conditions two parts of hydrogen combine with one part of oxygen to form water; but the result cannot be expressed merely as the sum of $2+1$, or yet as two qualities plus one quality, for the original qualities and powers vanish. We must say that two units added to one unit are preserved in the result as three units, but that something new has resulted—the properties of water. Any

explanation as to why this should happen is beyond the power of the human intellect: it is an ultimate fact. This is just the kind of thing that occurs when electrons combine to form a human mind. Under certain conditions, when a nervous system with a human brain is formed, we observe by indirect means that a unified consciousness results which has a common purpose and which is more than the sum of its parts; why this should occur is merely an observed fact. Indeed, it is thus with all ultimate questions. How can you give any reason why reality should be a machine or a plurality of minds or a single mind? It might conceivably be one of them, or perhaps none; we can only take reality as it is without accounting for its form, and describe its behavior as well as we can. One aspect of this behavior seems to be the mysterious, possibly illogical, fact that 2+2 do not, when applied to concrete reality as distinguished from the abstractions of mathematics, strictly make 4. Something new often arises from a concrete union of units. It is this fact, that the new is formed, which makes it possible to describe the world as an evolutionary process. Thus it seems to me that the compounding of mental units is no more difficult to understand than the compounding of anything.

It is true that water is an effect on other bodies or on a mind, but that when monads combine to form a mind there is nothing on which they can work other than the mind that is formed by their union. This is the essence of James's early position, as I understand it. Now, although I can see no reason why monads should combine to form a unity any more than I can see a reason why oxygen and hydrogen should unite to form a new substance which, provided there is any reality to act upon, exhibits new characters, yet both such phenomena apparently occur. The mind seems to be composed of parts unified into a whole which knows, in a way, its own unity and diversity; water seems also to be a whole composed of parts, but it reacts in a different way

from the sum of its parts and is not conscious of its unity. Why elements should combine in these ways is not deducible; the facts can only be observed; reality is what it is for no assignable reason. The assumption of an arch-monad or soul is merely the name for this unity; it does not in the least explain the process of unifying.

In a certain sense, then, we may talk about the fusion of elementary minds into a whole, but only in the sense that what we actually find in experience is a unity in a diversity. Fusion is only a name for the fact that parts do not exist except as parts of a whole. When we have artificially separated parts we must get them together again if we are to describe reality; but the truth is they were never separate. So in physics, physiology, and psychology we may in a sense use the word combination or fusion of elements as a convenient way of describing reality, but with the understanding that it is a somewhat artificial symbol, a shorthand way of describing nature.

And this leads naturally to the question whether monads, electrons, are ultimate realities, whether such a description of reality is final. There are indications that it is not; for there is of course the difficulty of joining together what has once been intellectually sundered, as well as the objection that such a description is artificial. To speak of a stone as an aggregate of little minds does appear fantastic. Then there is the more positive reason that physics may be able to dispense with any such description. If my interpretation of Mr. Eddington is right, Einstein's theory of Tensors, perhaps with additions, furnishes, in terms irrelevant to mechanism, an account of the behavior of reality which applies to any sort of reality no matter whether it is mind or matter. Conceivably, therefore, reality may sometime be described as a whole which behaves in certain ways, so that the process of evolution would be, not a change in the relations of the complexities of elements, but the growth of the

organic whole, in which of course parts could still be discriminated. And some such account of reality, I conceive, is nearer the truth.

By a sustained effort of thought it is possible for a short time to grasp as a whole the world process, our experience. It is then seen in its entirety as a conscious striving for more complete expression. But it is impossible to retain this vision long,—if it be a vision,—for we have an inveterate habit of relapsing to our individual points of view. When we think in these personal terms the unity of the process is lost and parts emerge. When a part emerges we then discriminate other parts, and parts within these parts, and finally reach an ultimate atomicity which is by idealism described as a world of monads. In the present state of science such a description seems inevitable for practical purposes. Probably, however, it is only provisional; there is hope that as science progresses new concepts may be formed which will enable us to formulate our descriptions in more adequate terms.

So we may perhaps conclude that reality is a whole that obeys certain laws; that its separation into elements is artificial, is good as a working hypothesis, and if rightly understood aids in description but is nevertheless only a provisional point of view. Therefore for the present I prefer to talk of the human mind as if it were the fusion of elements, because this is the easiest way to describe it if we use, as we must, the present language of science. Such a description means only that the mind is a whole in which parts are discriminated.[1] The objection that it seems forced and strange to describe the chair as mental is not pertinent, because this conception is no farther removed from ordinary ways of thought than to consider it as composed of

[1] For criticism of this point of view, see William McDougall, *Body and Mind, a History and a Defense of Animism*, 5th ed., 1920, pp. 357–377; *The Group Mind*, 1920, pp. 31–39.

vortices in the ether. One way, the physical, we are accustomed to; the other is unfamiliar and strange.

There is one more subject we must briefly discuss,—the creative advance of nature, the problem of novelty emphasized so strenuously by William James and Mr. F. C. S. Schiller, which is closely connected with that of causation.

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window. Does my conscious purpose here act or is it mere illusion? If all reality is mental, then the activity or behavior of mind or minds is what determines phenomena. Is this activity of mind what physics describes as a probable succession, or is this activity determined by its own inner nature, by its purposes? Now, I believe the answer is to be found in experience and there only. Which theory best describes the facts, which is the best working hypothesis?

The most general reason for thinking that purpose is active in the world is that it seems probable that, if nature has produced something which by reasoning can reach truth, it is rather absurd to hold that it has produced a being with ethical demands, with a conviction that purpose does count, and yet this part of his nature is illusion when the demand for unity in nature is not illusion. Truth, to be adequate and satisfying for us, must include the activity of purpose. If we can form no intelligible account of this activity, I suppose it must be rejected. But I do not think this is the case. In our examination of physical concepts we saw that nature, reality, is extremely active; also that nature shows a creative advance. What is this activity and how does it produce the new? William James, as we have seen, has in part answered this question. If possible his answer must be made more complete, and this James has done. Activity, in so far as it has any definite direction, is akin to what happens when we try to solve a problem or attempt to find words to express a meaning; and this activity is really creative, it brings into existence that which previously had no being other than in the realm of possibility.

"There is doubtless somewhere an original perceptual experience of the kind of thing we mean by causation, and that kind of thing we locate in various other places, rightly or wrongly as the case may be. Where now is the typical experience originally got?

CHAPTER XI

FINAL CAUSES

We left our discussion of causation in a rather unsatisfactory condition. Causation was probable expectation that one set of conditions would give rise to another. In the case of the stone we saw that purpose was a link in the chain. Moreover, following Dr. Whitehead and Mr. Alexander, we asserted that nature shows a creative progress. What, then, is real causation? How is anything new produced? It will be remembered that what we mean in scientific terms when we say the stone is the cause of the breaking of the window is merely that we have a right to expect that, when a moving stone hits a window, fracture will result. There is no *a priori* necessity involved, nor is it necessary to take account of the whole universe or of a first cause. Predictability in science still remains, but some difficulties in the ideas of causation have been removed. We saw that the stone moves because my arm moves first. What causes my arm to move? Mechanistic science says that the physical stimuli of the stone and window acting on my body, which at that moment has a definite, ideally describable physical constitution, produces the motion of my arm; that it is merely one of those highly probable successions of events; that consciousness may be present but it merely looks on.

It is possible to regard this phenomenon in another way. Suppose the window belongs to someone I dislike and wish to annoy. How can I annoy him? The sight of the window and stone suggests to me that I may annoy the person by breaking the window; I have the purpose to annoy, and knowledge of the properties of stones and windows gives me the means of carrying out my purpose. I raise my arm, throw the stone, and break the

release, ultimate *qualia* as they are of the life given us to be known. No matter what 'efficacies' there may really be in this extraordinary universe it is impossible to conceive of any one of them being either lived through or authentically known otherwise than in this dramatic shape of something sustaining a felt purpose against felt obstacles, and overcoming or being overcome. What 'sustaining' means here is clear to anyone who has lived through the experience, but to no one else; just as 'loud,' 'red,' 'sweet,' mean something only to beings with ears, eyes, and tongues. The *percipi* in these originals of experience is the *esse;* the curtain is the picture. If there is anything hiding in the background, it ought not to be called causal agency, but should get itself another name.

". . . The activity sets up more effects than it proposes literally. The end is defined beforehand in most cases only as a general direction, along which all sorts of novelties and surprises lie in wait. These words I write even now surprise me; yet I adopt them as effects of my scriptorial causality. Their being 'contained' means only their harmony and continuity with my general aim. They 'fill the bill' and I accept them, but the exact shape of them seems determined by something outside of my explicit will.

"If we look at the general mass of things in the midst of which the life of men is passed, and ask 'How came they here?' the only broad answer is that man's desires preceded and produced them. If not all-sufficient causes, desire and will were at any rate what John Mill calls unconditional causes, indispensable causes namely, without which the effects could not have come at all. Human causal activity is the only known unconditional antecedent of the works of civilization; so we find, as Edward Carpenter says,[1] something like a law of nature, the law that a movement from feeling to thought and thence to action,

[1] *The Art of Creation,* 1891, ch. i.

"Evidently it is got in our own personal activity-situations. In all of these what we feel is that a previous field of 'consciousness' containing (in the midst of its complexity) the idea of a result, develops gradually into another field in which that result either appears as accomplished, or else is prevented by obstacles against which we still feel ourselves to press. As I now write, I am in one of these activity situations. I 'strive' after words, which I only half prefigure, but which, when they shall have come, must satisfactorily complete the nascent sense I have of what they ought to be. The words are to run out of my pen, which I find that my hand actuates so obediently to desire that I am hardly conscious either of resistance or of effort. Some of the words come wrong, and then I do feel a resistance, not muscular but mental, which instigates a new instalment of my activity, accompanied by more or less feeling of exertion. If the resistance were to my muscles, the exertion would contain an element of strain or squeeze which is less present where the resistance is only mental. If it proves considerable in either kind I may leave off trying to overcome it; or, on the other hand, I may sustain my effort till I have succeeded in my aim.

"It seems to me that in such a continuously developing experiential series our concrete perception of causality is found in operation. If the word have any meaning at all it must mean what there we live through. What 'efficacy' and 'activity' are *known-as* is what these appear.

"The experiencer of such a situation feels the push, the obstacle, the will, the strain, the triumph, or the passive giving up, just as he feels the time, the space, the swiftness of intensity, the movement, the weight and color, the pain and pleasure, the complexity, or whatever remaining characters the situation may involve. He goes through all that can ever be imagined where activity is supposed. The word 'activity' has no content save these experiences of process, obstruction, striving, strain, or

release, ultimate *qualia* as they are of the life given us to be known. No matter what 'efficacies' there may really be in this extraordinary universe it is impossible to conceive of any one of them being either lived through or authentically known otherwise than in this dramatic shape of something sustaining a felt purpose against felt obstacles, and overcoming or being overcome. What 'sustaining' means here is clear to anyone who has lived through the experience, but to no one else; just as 'loud,' 'red,' 'sweet,' mean something only to beings with ears, eyes, and tongues. The *percipi* in these originals of experience is the *esse;* the curtain is the picture. If there is anything hiding in the background, it ought not to be called causal agency, but should get itself another name.

". . . The activity sets up more effects than it proposes literally. The end is defined beforehand in most cases only as a general direction, along which all sorts of novelties and surprises lie in wait. These words I write even now surprise me; yet I adopt them as effects of my scriptorial causality. Their being 'contained' means only their harmony and continuity with my general aim. They 'fill the bill' and I accept them, but the exact shape of them seems determined by something outside of my explicit will.

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from the world of dreams to the world of things, is everywhere going on. Since at each phase of this movement novelties turn up, we may fairly ask, with Carpenter, whether we are not here witnessing in our own personal experience what is really the essential process of creation. Is not the world really growing in these activities of ours? And where we predicate activities elsewhere, have we a right to suppose aught different in kind from this?

"To some such vague vision are we brought by taking our perceptual experience of action at its face-value, and following the analogies which it suggests.

"I say vague vision, for even if our desires be an unconditional causal factor in the only part of the universe where we are intimately acquainted with the way creative work is done, desire is anything but a close factor, even there. The part of the world to which our desires lie closest is, by the consent of physiologists, the cortex of the brain. If they act causally, their first effect is there, and only through innumerable neural, muscular, and instrumental intermediaries is that last effect which they consciously aimed at brought to birth. Our trust in the face-value of perception was apparently misleading. There is no such continuity between cause-and-effect as in our activity-experiences was made to appear. There is disruption rather; and what we naïvely assume to be continuous is separated by causal successions of which perception is wholly unaware. . . .

"Perception has given us a positive idea of causal agency but it remains to be ascertained whether what first appears as such, is really such; whether aught else is really such; or finally, whether nothing really such exists. Since with this we are led immediately into the mind-brain relation, and since that is such a complicated topic, we had better interrupt our study of causation provisionally at the present point, meaning to complete it

when the problem of the mind's relation to the body comes up for review." [1]

If we accept James's account, we have a vague idea of this creative process, but we are still in doubt as to how it operates. The difficulty, as James left it, is that we do not see how mental activity can operate on brain-cells. But, according to the view of reality I have tried to expound, brain-cells as material entities do not exist. What does exist is a total human being, a part of whose activity is purposive, a part habitual; a part of whom is usually called mental, a part physical, but the physical is really only the more permanent, common, and fixed aspects of the total activity. For convenience, we may say that the human being is an aggregate of monads whose minds and activities fuse into a unified whole. My purposive action in raising my arm to hurl a stone is, then, the common unified purpose of this whole aggregate. It is the striving of the whole and of each of its parts to do something; it is unified mental activity. That part of this activity which is common property to all minds, my body, is the so-called material activity. There is no new problem here as to how the mind influences the brain, for mind and brain are one. That part of the total mental reality, man, which we call the brain is what we all have in common. The total activity is this brain activity plus purpose, which is hidden from common observation. The activity of the brain is merely the observed part of the total-activity situation, which really is the purpose of the whole organism to throw the stone. If such a view be accepted, then one more difficulty is surmounted: since bodily activity is of the same nature as mental activity, the problem of how purpose affects the brain vanishes.

But another problem remains. How does my hand impart activity to the stone? Is this mere observed sequence or is a

[1] James, *Some Problems of Philosophy*, 1921, pp. 210–217. (Quoted by courtesy of Messrs. Longmans, Green, and Company, New York.)

more intimate connection discoverable? A variation in the statement of the problem will perhaps aid in solving it. Suppose my hands are tied behind my back; I may have the purpose to throw the stone and break the window, but nothing happens. I must first find means of sundering the cord that binds me. If the stone is too large for me to lift, I am likewise powerless. Purpose, then, is operative only when certain conditions are fulfilled. In order that my purpose may be effective I must know what are the proper conditions and how other bodies behave. These conditions and laws discovered, the purpose becomes fruitful. But why does the stone move upon impact? I know of no answer except that such is the nature of stones; it is merely a fact that we observe and take advantage of. So purpose, to be effective, must know the conditions under which it can operate; these conditions being given, the results follow from the nature of the realities concerned.

One more question clamors for an answer. Suppose we may intelligibly conceive how the mind influences the body and how the body influences other bodies, yet whence does purpose arise? Not an old purpose or a traditional purpose, but the idea of stating a new problem and of solving this problem; not the combining of old materials in the same old way, but the discovering of new materials and new combinations. Whence do we draw creative ideals of conduct, of art, of science? Only vague suggestions are at hand. There is a realm of possibilities open to the creative imagination; perhaps this may be Dr. Santayana's realm of essences which have being but no existence. In this realm fancy holds sway; from it new combinations may be pulled, but whether these new combinations apply to reality can only be determined by application to experience, by experiment. When they do so apply, a discovery has been made. When such a new combination is an ideal of conduct and the conditions of making it operative are discovered, then something new has

been brought into the world from this realm of possibility or essence. It is this creative power of the imagination that is the mysterious creative advance of nature.

It may be that a more definite form may be given to this realm of possibility; a suggestion, at any rate, was incidentally furnished by James when he was discussing another subject—the relations of finite personalities to reality. Although his argument rests largely on some phenomena of psychical research,—which are at present unproved and about which I am extremely sceptical,—nevertheless it contains a suggestion that may be of value. Let us see the lesson James draws from the alleged powers of mediums:

"What is one to think of this queer chapter in human nature? It is odd enough on any view. If all it means is a preposterous and inferior monkey-like tendency to forge messages, systematically embedded in the soul of all of us, it is weird; and weirder still that it should then own all this supernormal information. If on the other hand the supernormal information be the key to the phenomenon, it ought to be superior; and then how ought we to account for the 'wicked partner,' and for the undeniable mendacity and inferiority of so much of the performance? We are thrown, for our conclusions, upon our instinctive sense of the dramatic probabilities of nature. My own dramatic sense tends instinctively to picture the situation as an interaction between slumbering faculties in the automatist's mind and a cosmic environment of *other consciousness* of some sort which is able to work upon them. If there were in the universe a lot of diffuse soul-stuff, unable of itself to get into consistent personal form, or to take permanent possession of an organism, yet always craving to do so, it might get its head into the air, parasitically, so to speak, by profiting by weak spots in the armor of human minds, and slipping in and stirring up there the sleeping tendency to personate. It would induce habits in the subconscious

region of the mind it used thus, and would seek above all things to prolong its social opportunities by making itself agreeable and plausible. It would drag stray scraps of truth with it from the wider environment, but would betray its mental inferiority by knowing little how to weave them into any important or significant story.

"This, I say, is the dramatic view which my mind spontaneously takes, and it has the advantage of falling into line with ancient human traditions. The views of others are just as dramatic, *for the phenomenon is actuated by will of some sort anyhow,* and wills give rise to dramas. The spiritist view, as held by Messrs. Hyslop and Hodgson, sees a 'will to communicate,' struggling through inconceivable layers of obstruction in the conditions. I have heard Hodgson liken the difficulties to those of two persons who on earth should have only dead-drunk servants to use as their messengers. The scientist, for his part, sees a 'will to deceive,' watching its chance in all of us, and able (possibly?) to use 'telepathy' in its service.

"Which kind of will, and how many kinds of will are most inherently probable? Who can say with certainty? The only certainty is that the phenomena are enormously complex, especially if one includes in them such intellectual flights of mediumship as Swedenborg's, and if one tries in any way to work the physical phenomena in. That is why I personally am as yet neither a convinced believer in parasitic demons, nor a spiritist, nor a scientist, but still remain a psychical researcher waiting for more facts before concluding.

"Great Scientific Conquests of the Future

"Out of my experience, such as it is (and it is limited enough) one fixed conclusion dogmatically emerges, and that is this, that we with our lives are like islands in the sea, or like trees in the forest. The maple and the pine may whisper to each other with

their leaves, and Conanicut and Newport hear each other's fog-horns. But the trees also commingle their roots in the darkness underground, and the islands also hang together through the ocean's bottom. Just so there is a continuum of cosmic consciousness, against which our individuality builds but accidental fences, and into which our several minds plunge as into a mother-sea or reservoir. Our 'normal' consciousness is circumscribed for adaptation to our external earthly environment, but the fence is weak in spots, and fitful influences from beyond leak in, showing the otherwise unverifiable common connection. Not only psychic research, but metaphysical philosophy, and speculative biology are led in their own ways to look with favor on some such 'panpsychic' view of the universe as this. Assuming this common reservoir of consciousness to exist, this bank upon which we all draw, and in which so many of earth's memories must in some way be stored, or mediums would not get at them as they do, the question is, What is its own structure? What is its inner topography? This question, first squarely formulated by Myers, deserves to be called 'Myers's problem' by scientific men hereafter. What are the conditions of individuation or insulation in this mother-sea? To what tracts, to what active systems functioning separately in it, do personalities correspond? Are individual 'spirits' constituted there? How numerous, and of how many hierarchic orders may these then be? How permanent? How transient? And how confluent with one another may they become?

"What, again, are the relations between the cosmic consciousness and matter? Are there subtler forms of matter which upon occasion may enter into functional connection with the individuations in the psychic sea, and then, and then only, show themselves?—So that our ordinary human experience, on its material as well as on its mental side, would appear to be only an extract from the larger psycho-physical world?

"Vast, indeed, and difficult is the inquirer's prospect here, and the most significant data for his purpose will probably be just these dingy little mediumistic facts which the Huxleyan minds of our time find so unworthy of their attention. But when was not the science of the future stirred to its conquering activities by the little rebellious exceptions to the science of the present? Hardly, as yet, has the surface of the facts called 'psychic' begun to be scratched for scientific purposes. It is through following these facts, I am persuaded, that the greatest scientific conquests of the coming generation will be achieved. *Kühn ist das Mühen, herrlich der Lohn!*" [1]

Without accepting the facts of psychical research to which James alludes, let us see what the suggestion of a "sea of consciousness" is worth. You will remember that the view of reality we have advocated implies that minds exist in some sort of relation, perhaps like the parts of an organism to the whole. This kind of relation seems necessary if minds are to know each other. It may be that reality other than my mind is also the realm of essence or possibility, is just such a sea of consciousness as James describes. It may be that, just because we are in relation to it but of course not wholly conscious of all details of this relation, we are able to draw from this realm to make new combinations and discoveries, to form ideals that may become operative. With such a vague and unsatisfactory account of the creative activity of mind I am of course not content, but clear light is lacking.

Dr. Hocking has a suggestion, reached from a different point of view and used for a different purpose, which is not inconsistent with the opinion that there is some existence that might be described as a storehouse, or source of inspiration, from which

[1] James, "The Confidences of a 'Psychical Researcher,'" in *American Magazine*, lxviii (May-Oct., 1909), 588-589. (Quoted by courtesy of the Crowell Publishing Company, New York.)

we draw our creative power.[1] He holds, according to my understanding, that if it were not for our prior knowledge of anotber mind objective nature would not exist for us, for objectivity is the knowledge that objects are common to at least two minds. Then, since nature is an infinite process and is likewise independent of being known by any finite mind, apparently to have an idea of objective nature must imply the prior idea of an infinite mind that knows nature in common with us. Such an idea is the absolute, and the absolute is actually experienced in nature. From such a being we might conceivably draw new knowledge and inspiration.

The objection to such a view is tbat the absolute is destructive of human endeavor and raises an insoluble problem of evil. If modified, such a conception would not be far removed from the idea suggested by James, at least if it is regarded merely as a description of the source of the new.

It seems not improbable that there exists in some part of the universe a mind — or minds — of far greater insight than our own. But, even if we could draw new inspiration from such a mind, would that account for the creative progress of nature? According to science, unless the absolute exists, reality is in a process of evolution — the new is being created. It helps little to say that this creation is the power of a higher mind, and that we partake of it in only a passive way by merely learning what has already been accomplished. We do not explain or make intelligible the creative advance of nature by positing a higher mind; we merely push the problem farther back. If we are moral agents this power of creation must exist in us. We apparently find it in ourselves when we form and carry out a new ideal of conduct. That the test of the value and validity of such an ideal is given by experience, there is little doubt. But can the creation

[1] W. E. Hocking, *The Meaning of God in Human Experience*, 1912, ch. xxxi. "The Creativity of Religion: Theory of Inspiration."

of the new, or a new discovery, be wholly a re-combination of past experience? Since nature apparently shows a creative advance, I cannot believe that the new is wholly such a re-combination.

James made another suggestion about the discovery of the new which seems to hit nearer the mark. A genius is a being who by greater knowledge, sharper perceptions and instincts, keener mental powers, is able through a process of mental trial and failure to discover new knowledge and ways of action which work. The powers used by a genius are similar to those of any other intelligent being. They are primarily the powers of discrimination, of being able to distinguish similarity and difference, and of memory. But especially is the power of picking out similarities the mark of genius. Newton's falling apple is seen to be a case of the behavior of all other bodies; all bodies are like it in respect to the law of gravitation.[1] Here the stroke of genius is a new scientific discovery. But in this example nothing new is brought into the world; something new is found out about an old world.

In some ways creative imagination acts differently from the process we have been considering. Let us take, for example, the discovery of vaccination for smallpox. Dr. Edward Jenner was interested in the causes of smallpox and, perhaps not with full self-consciousness, was searching for a remedy against it. He knew that individuals who had suffered from smallpox were relatively immune, and it was suggested to him by local traditions that individuals who had contracted cowpox were also relatively immune. Noticing the similarity between the two causes of immunity, he asked himself if it would not be possible to make individuals artificially immune by vaccination with matter from the cowpox vesicles obtained from human individuals who had cowpox. He tried the experiment and succeeded.

[1] James, *Psychology*, 1890, ii, 310–371.

The mental processes in the discovery of artificial immunity through vaccination may not have been so explicit as our partly imaginative description. This discovery may have been the work of a vague striving for a remedy, a rejection of all sorts of schemes, finally a burst of insight suggested by a chance remark that cowpox renders one immune to smallpox,—"Yes, that is what I am searching for! Let me try it and see if it works." Here the mental processes, whether fully present to consciousness or not, are the recognition of similarities between ideas whether articulate or inarticulate, the more or less conscious striving for an end, and the rejection of all ideas not in accord with this purpose. The result of these processes was the introduction of artificial immunity against smallpox; that is, something new was brought into our world. Did this fact of artificial *immunity exist previously in the realm of essences, in James's* reservoir, in the absolute? Who can answer?

Let us take another example, drawn largely from fancy but perhaps not wholly devoid of truth. Christ was born of humble parents, yet he received some bookish education; he was somewhat familiar with the social conditions of his time; he was able to dispute with the elders in the synagogue. Eventually he achieved an insight into reality which took the form of an ideal of the relation of God and man, and of an interpretation of the meaning of human experience, never previously attained in a degree approaching the perfection achieved by him. The essence of this ideal is, for me, that reality is a community of spirits, the worth of human individual endeavor is preserved, and the rule for conduct is love. Christ has best expressed this.

I am especially anxious to avoid controversy at this point, and to make an assertion about Christianity, not complete but true as far as it goes, which all will accept as being at least a part of Christianity. I must assume that my statement of these ideals will be accepted in the qualified sense just indicated.

That this ideal was in a very real sense a new one is another proposition to which I hope all will assent. Whether it was in part transmitted to Christ by tradition or hy the written word is immaterial for our special purpose. If he did not originate it someone else did; it was something new in the world. But I fear this will not he so easily admitted by all. Let us try to state it in such a way as to secure general assent.

There are several descriptions of the process through which Christ reached this new ideal. The orthodox one is that the truth either was revealed hy God or was spoken hy God in person. A naturalistic account could hold that the universe is constituted as Christ said, and that Christ by ahnormal sagacity discovered this truth. Another naturalistic account might assert that the world can be a world of love if we coöperate, and that Christ discovered this truth. Still another might hold that ideals, including even the Christian ideal, are shams, — that all reality is matter.

The materialistic account I must reject even at the risk of losing unanimity. Perhaps it is possible so to state the others that all except pure materialists will agree that Christ's ideal was a new creation which actually made a new reality, at least for the world we inhabit.

Whether one accepts the Biblical account of history, that Adam was created in the image of God, that Eve was made from his rib, and that we are descendants of the original pair, or the scientific account that we are descended from original forms of life the first beginnings of which on earth must have been the result of an infinite process, it seems absurd to hold that the teachings of Christ were known when the process began. According to the Biblical account, Adam and Eve could not possibly have acquired such an ideal until after they had eaten of the fruit of the Tree of Knowledge; and it is absurd to hold that it was explicit in the primeval nebula. So perhaps we may assume

that all except materialists agree that ideals operate and are new creations. We must now ask, How do such creative ideals as those of Christ arise? Here I no longer look for agreement, but must give my own reasons for what I have to say. There are two general ways of answering the question. Either ideals are formed by a revelation of God or by his spoken word; or else they are formed in a natural way which can be intelligibly stated and which preserves both the validity of a scientific account and the moral value of the individual.

If ideals are the act of God, or a passive knowledge of the mind of God, they are, it is true, creative of phenomenal activity in this world, but they are not creative of reality. Reality is what God thinks. The difficulties of the absolute reappear. Such a solution is not in accord with scientific concepts. It may, however, be the answer; but a naturalistic account is to me more probable.

In whatever way Christ's ideals came to him, they were expressed in human, bodily form: he was born; he endured infancy, maturity, death. At least in his human aspect his mind must have worked as a human being's. There is much evidence that it did. We may fairly think, then, that Christ's completed ideal was not present to him in the manger, but developed in part from the action of his environment, which included his education and did not necessarily exclude God. He must have had a desire for knowledge and some capacity to absorb knowledge. He must have wished to aid his fellows and to lead a life that would make for virtue and happiness. This great sagacity and this burning desire enabled him, by picking out from his experience the essentials of life that were similar to his vague but powerful desire, to formulate his ideal.

If Christ was in a supernatural way the son of God, he came into this world with a heritage from the infinite, with powers of responding to environment determined by an infinite past. But

this is likewise true if he was man born of woman in the ordinary way. So in either case my picture of Christ is that of a being who inherits his powers from an infinite process, who is an encloser, or container, of the infinite process, and who has an instinctive reaching out toward this infinite. Christ had this instinctive power in a very high degree, coupled with great powers of discrimination and with great sagacity. It is this instinctive striving determined by an infinite inheritance, together with sagacity, memory, and discrimination, that enables all other beings, as it enabled Christ, to form ideals. They also are "containers," or "enclosers," of the infinite process. This instinctive striving determined by infinite causes is what gives momentum to the creative advance of nature.

Sagacity is what largely determines the means for such advance. It rejects what is not in accord with this instinctive feeling, and in its developed form — the power of using intelligence for recognizing similarities — may be increased by practice. Perhaps also the amount of instinctive striving may be increased. These powers are only figuratively to be spoken of in quantitative terms; they are not cases of the conservation of energy, for they are not closed systems but infinite systems. This quantitatively undetermined power of the instinctive desire resulting from an infinite heritage governed by reason is the expression of the creative imagination. It operates as feeling, as purpose, as a striving to do something which continually rejects all not like itself; thus it forms an ideal that operates in the world and creates the new.

It is, however, true that in the highest flights of such creative activity the answer seems to come from outside, as an intuitive insight. All who work on intricate problems know that such a problem may apparently solve itself over night or as the result of what seems like a vision or a revelation. Is such spontaneous

solving of a problem a sign of communication with a higher power?

What I am trying to suggest is that any great ideal, like that of Christ, does actually operate in the world, and that the formation of such an ideal cannot be stated except as the result of the operation of an infinite instinct which is the result of a heritage that is actually infinite. Such an instinct is not a desire to feed, plus one to propagate, plus one to aggrandize one's self, plus one to gather in herds. It is an infinite instinct to which only a rational idea of the infinite can give expression. To apply to such an infinite instinct ideas of the conservation of energy and of physical determination seems absurd.

It is with such meagre and unsatisfactory suggestions that we must leave Dr. Whitehead's mysterious advance of nature, not because an adequate and satisfying account has been given but because the complete one is yet to be found.[1]

Before proceeding to the next part of our inquiry, let me state in a few words the theory of reality we have thus far formulated. Reality is mind and is pluralistic; yet it is not unconnected, for, since knowledge is possible, as is shown by the fact that science gives truth, minds must overlap, must be conterminous, must exist as parts of a whole. The material world is such part of my ideas as are common to you and to me and to the object; the laws of the world are the more permanent and fixed modes of behavior of mind. Inasmuch as science usually describes reality as aggregates of electrons, these electrons may be regarded as little minds or monads, which combine to form larger aggregates and sometimes to form minds; but this description is not final but convenient. Causation is purposive activity, and physical

[1] Cf. F. C. S. Schiller, "Novelty," Aristotelian Society, *Proceedings*, 1921–1922, pp. 1–22 (the presidential address); W. E. Hocking, *Human Nature and its Remaking*, 1918; William James, *Some Problems of Philosophy*, 1921, chs. ix–xii.

causation is this activity become relatively fixed and permanent. Purpose is the creative advance of reality, of which only a vague and unsatisfactory account can be given; but it may be affirmed that purpose creates reality not only by striving but also by choosing the points of view, the conditions from which the observer shall view the reality thus created. The most real aspect of the world depends on the valuation of experience and on the choice of the point of view by the observer. Thus metaphysics is made to depend on ethics. To assume that knowledge and experience are possible at all implies certain powers of mind that have merely been mentioned, such as memory, the ability to recognize degrees of similarity and difference, and the sense of duration or succession. Without at least these powers, knowledge is impossible on any theory; and obviously conscious, purposive activity and the progressive advance of nature stated in mental terms are also unthinkable. I know of no analysis that throws light on these mysterious powers.

There are of course other deficiencies in our theory as given. No mention has been made of personality, only slight mention of the soul, and no mention of immortality, ethical freedom, God. The few suggestions we shall furnish on these subjects are best reserved until we have a somewhat more concrete picture of the human organism. So let us take the theory as a hypothesis, as a creation of the imagination which has some consistency and plausibility, and treat it as we would any scientific hypothesis. Let us apply it to the concrete facts of science, so far as we can discover such facts, in order to determine whether the theory works.

CHAPTER XII

EVOLUTION

Cosmic Evolution

Our attempt to understand what is meant by a psychology of character has led us to reject the orthodox physical account of the world and to hold that reality can be intelligibly stated only as a community of minds. The realities of the physical world we have, however, retained, but only as psychic realities provisionally described as *monads*; and we have insisted that science gives truth, because it discovers the empirical laws of the behavior of such realities, laws which give some degree of truth. Thus we may regard our previous work as the formulation of a hypothesis about reality which is more intelligible than other hypotheses and therefore should be accepted.

It remains to be determined whether our theory is in accord with the facts or laws that science has discovered about reality. And this brings us to another difficulty: science is not at present a unified whole; it consists of divisions interrelated but as yet not coördinated into a consistent whole,[1] and it may well be that this is a consequence of difficulties inherent in the concepts of the special sciences.[2] But, in spite of all this, there is a generalization on which all scientists agree,— that the present cannot be understood without consideration of the past, that the study of nature shows that the present has evolved from the past, that nature has a history. It is the broad line of this evolution which it is our present task to consider. The chief purpose of the examination is to show that neither a materialistic nor a dual-

[1] L. J. Henderson, *The Order of Nature*, 1917, p. 110.

[2] J. Arthur Thomson, *The System of Animate Nature*, 1920, i. 8–25.

istic account of nature makes evolution intelligible, whereas a world of monads does, and that there is much evidence to indicate that all parts of nature embody the same kind of reality. Several subordinate purposes will also be served. Thus, a human being is a part of nature, and without some understanding of the relation of man to nature no science of mind is possible.

We have seen that it is possible to interpret scientific law and reality in a way that will preserve the moral worth of character. But we have also seen that what we know about reality is given, at least chiefly, by science. Now, what science teaches us, apart from specific facts of commercial value, is embodied in the vague concept of evolution. Any philosophy of character must therefore recognize man's place in nature and be consistent with the generally recognized facts of evolution. If it should by good fortune be able so to interpret evolution as to reconcile conflicting views, then another support is given to the validity of such a philosophy.

In our study of evolution we shall wish to emphasize several points. (1) The very idea of evolution is unintelligible without some concept of an end; evolution as mere mechanism is not intelligible. (2) This conviction that nature does embody purpose is held by many scientists; but that natural law is operative is also certain. Since these two views, that nature exhibits purpose and that nature is mechanistic, are so persistent, it would seem that in some way both must contain truth. To be satisfactory, a theory must in some way reconcile these two points of view. (3) What science really shows is that reality is one, so that a human being is of the same nature as, let us say, electrons; but science does not prove that nature is material. (4) Materialistic mechanism fails in so many respects to make reality intelligible that it is presumptuous for science to hold that nature must be explained by mechanism alone. (5) Since our theory

meets many of the difficulties we shall discover, since it can be stated so as to be in accord with the facts of science, and since on the whole it is more intelligible, it should be accepted. (6) Many important facts about the human organism, valuable for our study of character, will be acquired as we proceed.

In our previous discussion we have had occasion to refer many times to the general outlook of science as expressed by Laplace, Loeb, Henderson, and Russell. Let us try to form a somewhat more concrete picture of this world of orthodox science. We have seen in general that it is a universe of necessary law imposed on us from without. The chief conception is that the events of this present moment which has now passed were determined by conditions of previous moments, and so on indefinitely, not to say infinitely. Now, in order to give a scientific account of such a world, we go back in time as far as our mental vision will take us and attempt to discover the conditions which then existed and to form such a theoretical interpretation of these conditions that the ensuing course of events will follow. The time at which the scientific account starts, the beginning of scientific history, is very vague. We cannot even approximately set down in concrete figures of numbers of years the date when the history of our world began; and it is important to remember that, go as far back as we may, we must always think that previous to our arbitrary starting-point other conditions which determined this point existed. The arbitrary point selected as the beginning of our scientific history is that which existed immediately prior to the formation of our solar system. Science attempts to state the conditions out of which our solar system in its present form came into being, and more specifically to explain the earth on which we live and the various phenomena of organic and inorganic change:

"The general course of the evolutionary processes as applied to the principal classes of celestial bodies is thought to be fairly

well known. With very few exceptions astronomers are agreed as to the main trend of this order, but this must not be interpreted to mean that there are no outstanding differences of opinion. There are, in fact, some items of knowledge which seem to run counter to every order of evolution that has been proposed.

"The large irregular nebulæ, such as the great nebula in Orion, the Trifid nebula, and the background of nebulosity which embraces a large part of the constellation of Orion, are thought to represent the earliest form of inorganic life known to us. The material appears to be in a chaotic state. There is no suggestion of order or system. The spectroscope shows that in many cases the substance consists of glowing gases or vapors; but whether they are glowing from the incandescence resulting from high temperature, or electrical condition, or otherwise, is unknown, though heat origin of their light is the simplest hypothesis now available. Whether such nebulæ are originally hot or cold, we must believe that they are endowed with gravitational power, and that their molecules or particles are, or will ultimately be, in motion. It will happen that there are regions of greater density, or nuclei, here and there throughout the structure which will act as centers of condensation, drawing surrounding materials into combination with them. The processes of growth from nuclei originally small to volumes and masses ultimately stupendous must be slow at first, relatively more rapid after the masses have grown to moderate dimensions and the supplies of outlying materials are still plentiful, and again slow after the supplies shall have been largely exhausted. By virtue of motions prevailing within the original nebular structure, or because of inrushing materials which strike the central masses, not centrally but obliquely, low [slow?] rotations of the condensed nebulous masses will occur. Stupendous quantities of heat will be generated in the building-up process.

This heat will radiate rapidly into space because the gaseous masses are highly rarefied and their radiating surfaces are large in proportion to the masses. With loss of heat the nebulous masses will contract in volume and gradually assume forms more and more spherical. When the forms become approximately spherical, the first stage of stellar life may be said to have been reached."[1]

By comparison of the spectra of the nebulæ with those of the stars, different classes of stars have been tabulated, largely through the efforts of the Harvard Observatory. It is believed that the first stage of star-life is found in the very hot, blue stars, the helium stars, Class B. Then come the hydrogen stars, Class A, which are also blue stars; Class G, yellow, a stage between the hydrogen stars and our sun; Class K, yellowish red; Class M, red. "The period of existence succeeding the very red stars has illustrations near at hand, we think, in Jupiter, Saturn, Uranus and Neptune, and in the Earth and the other small planets and the Moon: bodies which still contain much heat, but which are invisible save by means of reflected light."[2] Such is the general order of cosmic evolution. But when we ask what are the specific stages of this process we find that authorities differ; according to Poincaré,[3] Barrell,[4] and Campbell,[5] there is apparently no wholly satisfactory theory. Let us see what Poincaré has to say:[6]

All theories start from two facts: (1) The orbits of all the

[1] William Wallace Campbell, "The Evolution of the Stars and the Formation of the Earth," in *Popular Science Monthly* (now *Scientific Monthly*) for September, October, November, December, 1915. For this particular quotation, see the October issue, pp. 10–11. (Quoted by courtesy of the editor of the *Monthly*.)

[2] *Ibid.*, p. 15.

[3] H. Poincaré, *Leçons sur les hypothèses cosmogoniques*, 1911, p. xxv.

[4] *Joseph Barrell*, "*The Origin of the Earth*," in *The Evolution of the Earth and its Inhabitants*, ed. R. S. Lull, 1920.

[5] Campbell, *op. cit.*, December, p. 255.

[6] Poincaré, *op. cit.*, pp. v–xxv.

planets are nearly circular and are in the same plane; the planets move in these orbits in the same direction. These facts cannot be due to chance. (2) The second law of thermodynamics shows that the energy of the system is being dissipated. Our universe changes, and finally all parts must reach a uniform temperature. The theory of Laplace modified in certain respects explains these facts best, provided we consider only our own solar system. Laplace thought our system was formed from an incandescent nebula which formerly extended beyond the orbit of Neptune. This incandescent nebula rotated uniformly but was not homogeneous, being markedly condensed in the center. In cooling it contracted and rings were formed about the equator, and these rings finally broke and formed spherical masses, the planets. When one calculates the time necessary to bring about the uniform rotation of this incandescent gas, one gets fantastic figures — some thousands of millions of years. To preserve the harmony thus slowly acquired, the cooling and contraction of such a mass must also have been prodigiously slow; it probably took several hundreds of millions of years to form a ring. But this is a short period when the whole process is considered. The planets in their turn either formed rings and satellites or by their attraction captured wandering bodies, as our moon may have been captured; they gradually cooled, and conditions suitable for life as we know it arose. Since Laplace, studies on the function of the tides have shown that the rotation of the planets is gradually slowing down and will probably sometime cease. Moreover, the heat of the system supplied by the sun is gradually being lost by radiation and must ultimately, it would seem, be exhausted, leaving a dead, frozen world rolling through space until destroyed by a chance collision with some other body. Various theories have been formed as to the source of solar heat. That it is the product of a process of combustion like that of coal is inadequate because the time in which the available

supplies of the sun would be consumed is too short to fit in with other requirements. That the source of heat is due in part to showers of meteorites falling to the sun and thus adding to its heat is also inadequate. The theory that the heat of the sun is due to contraction of its volume, which furnishes ten thousand times as much energy as the theory of combustion, is more satisfactory; but even this theory does not give the geologist sufficient time to account for the changes observed on the earth, which require at least 200 millions of years since the beginning of the Devonian period, whereas even on the contraction theory heat is furnished for only about 50 millions of years. The discovery of radio-activity and of the vast stores of energy liberated by the breaking-up of atoms gives the answer that was long sought in vain. Time enough is thus probably furnished to the geologist to account for the changes due to the internal and external conditions that affect the earth, and to the biologist for the slow transformation of species.

This theory of the evolution of our solar system is not universally accepted. Among the chief constructive critics are Moulton and Chamberlin. Their theory postulates our sun, which had condensed from a primal nebula. By tidal forces generated by a passing star spiral nebulæ were formed, which in turn condensed to form our planets with their satellites. If two stars approach so near that they may be said to graze, a spiral nebula is formed. This nebula revolves about its parent in an elliptic orbit after the disturbing star has passed on, and presently develops a hot nucleus surrounded by cold, gaseous matter. This is what happened to our sun. Several spiral nebulæ may have been formed, the principal nuclei of which were the beginnings of our planets, which, according to Chamberlin, drew in new material, largely in the form of dust. Chamberlin holds that "the stages of earth-growth were very prolonged, even geologically speaking, and that the accretion was dominantly of

dust-like or molecular particles. According to him the building up of the planets followed three stages: first, the direct condensation of the nuclear knots of the spirals into liquid or solid cores; second, the less direct collection of the outer, or orbital and satellitesimal; third, the still slower gathering up of the planetesimal material scattered over the zone between adjacent planets. This third factor, in Chamberlin's view, is regarded as very important and he believes this diffused matter contributed much of the earth substance, very slowly and in a dust-like form." [1]

Neither of these theories is wholly satisfactory, and Poincaré, Campbell, and Barrell hold that there is no theory that explains all the facts.

But, however unsatisfactory such a result may be, certain general conclusions are possible: (1) every cosmological theory gives some sort of vague picture of the formation of the earth from aggregations of matter in a nebulous or a meteoritic state;[2] (2) at some stage in its history the earth was a molten mass, with possibly a solid core;[3] (3) all cosmological theories explain this process according to invariable physical law; (4) no specific account of the process is generally accepted. Turning, then, to the evolutionary process on the earth, "we may," in the words of Dr. Daly, "conclude that the planetesimal-nebular hypothesis, like the older gas-nebular and meteoritic hypotheses, does not forbid belief in: (a) a former molten stage for the earth's external shell; (b) the density stratification of this planet; (c) a fairly uniform composition for the surface shell; (d) general magmatic temperatures not more than a few miles below the surface, throughout geological time. Important as the

[1] Barrell, *op. cit.*, pp. 18 ff. (the lines quoted are at pp. 24–25; they are reprinted here by courtesy of the Yale University Press, New Haven). Cf. Campbell, *op. cit.*, December, pp. 238–243; and T. C. Chamberlin, *The Origin of the Earth*, 1916.

[2] Barrell, *op. cit.*, p. 8.

[3] Barrell, *op. cit.*, pp. 26, 30; Campbell, *op. cit.*, p. 253.

planctesimal hypothesis is in cosmogony, it does not seem to affect the traditional view of geologists as to the thermal condition of the globe." [1]

But, before examining the process of evolution on the earth, we must mention certain other aspects of cosmic evolution, especially the time required for the formation of the earth, what the future has in store, and the possibility of the evolution of the chemical elements from some common stuff. All this seems a long way from the study of character, but it does have a very decided bearing. Apart from the question whether nature can be expressed mechanically, it is of great interest to know how long evolution has been going on and how long we may reasonably expect it to continue. If evolution is to continue only for a comparatively brief number of years, after which the machine will run down, there is little incentive to human endeavor, unless indeed this life is a preparation for a life to come Science tells us little or nothing about such a future life, and it is of course a serious question whether there is any But surely, if human evolution has just begun and if there is a probability that it may go on for a comparatively long period, the outlook is encouraging; for the possibility that some of the questions now apparently well-nigh insoluble may eventually be answered becomes one that may be rationally entertained.

Mr Campbell gives in a few words what is actually known about the age of the earth "Geologists estimate from the deposition of salt in the oceans, and from the rates of denudation and sedimentation, that the formation of the rock strata has consumed from 60,000,000 to 100,000,000 years If the Earth had substantially its present form 80,000,000 years ago we are safe in saying that the period of time represented in the building

[1] R A Daly, *Igneous Rocks and their Origin*, 1914, p 159 (quoted by courtesy of the McGraw-Hill Book Company, New York) Cf Barrell, *op cit*, p 36

up of the Earth from a small nucleus to its present dimensions has been vastly longer, probably reckoned in the thousands of millions of years."[1] The earliest fossil bacteria are found in deposits estimated to be about 33,000,000 years old,[2] and life must have existed long before. The age of man (*Pithecanthropus erectus*) is put by Osborn at about 500,000 years and that of our immediate ancestors at more than 25,000.[3] Long as this period is, it becomes insignificant, as compared with geological and cosmic times, and still more trivial is the 6000 years comprising the history of civilized nations. This clearly shows that the evolutionary process is exceedingly slow and that we should not expect great changes in a short time. The evolution of man has been but a moment in the total process.

To return now to our description. "The evolutionary processes must proceed with extreme deliberation. The radiation of the heat actually present at any moment in a large helium star would probably not require many tens of thousand of years, but this quantity of heat is negligible in comparison with the quantity generated within the star during and by the processes of condensation from the helium age down to the Class M state. We know that the compression of any body against resistance generates or releases heat. Now a gaseous star at any instant is in a state of equilibrium. Its internal heat and the centrifugal force due to its rotation about an axis are trying to expand it. Its own gravitational power is trying to draw all of its materials to the center. Until there is a loss of heat no contraction can occur; but just as soon as there is such a loss gravity proceeds to diminish the stellar volume. Contraction will proceed more slowly than we should at first thought expect, because in the process of contraction additional heat is generated and this

[1] Campbell, *op. cit.*, p. 255.
[2] Henry Fairfield Osborn, *The Origin and Evolution of Life*, 1916, p. 86.
[3] Osborn, *Men of the Old Stone Age*, 1914, pp. 41, 108, 501.

becomes a factor in resisting further compression. Contraction is resisted vastly more by the heat generated in the process of contraction than it is by the store of heat already in evidence. The quantity of heat in our Sun, now existing as heat, would suffice to maintain its present rate of outflow only a few thousands of years. The heat generated in the process of the Sun's shrinkage under gravity, however, is so extensive as to maintain the supply during millions of years to come. Helmholtz has shown that the reduction of the Sun's radius at the rate of 45 meters per year would generate as much heat within the Sun as is now radiated. This rate of shrinkage is so slow that our most refined instruments could not detect a change in the solar diameter until after the lapse of 4000 or 5000 years. Again, there are reasons for suspecting that the processes of evolution in our Sun, and in other stars as well, may be enormously prolonged through the influence of energy within the atoms or molecules of matter composing them. The subatomic forces residing in the radioactive elements represent the most condensed form of energy of which we have any conception. It is believed that the subatomic energy in a mass of radium is at least a million-fold greater than the energy represented in the combustion or other chemical transformation of any ordinary substance having the same mass. These radioactive forces are released with extreme slowness, in the form of heat or the equivalent; and if these substances exist moderately in the Sun and stars, as they do in the Earth, they may well be important factors in prolonging the lives of these bodies."[1]

But the earth is of course losing heat through radiation, and according to the generally accepted theory it will ultimately cool off, although it is probable that some retarding processes are at work, just as in the processes preceding the formation of the earth and in the cooling of the sun. "Uranium and thorium,

[1] Campbell, *op. cit.*, October, pp. 16–17.

the parents of the radioactive series, are widely though sparsely diffused through the lithosphere. It has been calculated that, if they extend in their surface amount to a depth of 40 miles, they must supply heat to the surface as fast as it is lost by radiation into space. The earth therefore appears not to be growing colder, though losing heat."[1] "On this view, it is to be expected that the radioactive materials will be confined to the crust and be absent from the metallic core, and, therefore, that the crust may have reached a steady temperature, at which the loss of heat by radiation is exactly balanced by the heat evolved by its radioactive constituents. If this is so, the present state would continue without much change for hundreds of millions of years.

"Be this as it may, our outlook on the physical universe has been permanently altered. We are no longer the inhabitants of a universe slowly dying from the physical exhaustion of its energy, but of a universe which has in the internal energy of its material components the means to rejuvenate itself perennially over immense periods of time, intermittently and catastrophically, which is the first possibility that presents itself, or continuously and in orderly fashion, if there exist compensating phenomena still outside the ken of science. . . . Radium has taught us that there is no limit to the amount of energy in the world available to support life, save only the limit imposed by the boundaries of knowledge.

"It cannot be denied that, so far as the future is concerned, an entirely new prospect has been opened up. By these achievements of experimental science Man's inheritance has increased, his aspirations have been uplifted, and his destiny has been ennobled to an extent beyond our present power to foretell. The real wealth of the world is its energy, and by these discoveries it, for the first time, transpires that the hard struggle for existence on the bare leavings of natural energy in which the race has

[1] Barrell, *op. cit.*, p. 42.

evolved is no longer the only possible or enduring lot of Man. It is a legitimate aspiration to believe that one day he will attain the power to regulate for his own purposes the primary fountains of energy which Nature now so jealously conserves for the future. The fulfilment of this aspiration is, no doubt, far off, but the possibility alters somewhat the relation of Man to his environment, and adds a dignity of its own to the actualities of existence." [1]

But it must not be concluded, according to Sir Ernest Rutherford, that these radio-active processes do more than retard the cooling-off. "The long continued emission of energy from the radioactive bodies does not on this view present any fundamental difficulty and is in accordance with the principle of the conservation of energy. The matter loses in atomic energy at each stage of the transformation, and the energy radiated is derived from the internal energy resident in the atoms themselves." [2] "The emission of energy from radioactive substances does not controvert the law of the conservation of energy; for the energy is derived from the atom itself where it exists in kinetic or potential form." [3] Ultimately, then, the cosmic process must become exhausted, for radio-activity conforms to the laws of the conservation and degradation of energy; unless some undiscovered compensating principle is at work, the machine must eventually run down.

"We have said that the evolutionary processes depend primarily upon the loss of heat. This is to the best of our knowledge a genuine loss, except as some of the heat rays happen to strike other celestial bodies. The flow of heat energy from a star must

[1] Frederick Soddy, *The Interpretation of Radium*, 4th ed , 1920, pp 180–181, 185 (Quoted by courtesy of John Murray, Esq , London)

[2] Rutherford, *Radioactive Transformations*, 1906, p 14 (By courtesy of Charles Scribner's Sons, New York)

[3] Rutherford, "The Constitution of Matter and the Evolution of the Elements," in *Popular Science Monthly*, August, 1915, p 127. (By courtesy of the editor of the *Monthly*)

be essentially continuous, always in one direction from hotter bodies to colder bodies, or into so-called unending and heatless space. Temperatures throughout the universe are apparently moving toward uniformity, at the level of absolute zero. Now, this uniformity would mean universal stagnation and death. It is possible to have life and to do work only when there are differences of temperature between the bodies concerned: work is done or accompanied by a flow of heat, always from the hotter to the colder body. We are not aware that any compensating principle exists. Several students of the subject, notably Arrhenius, have searched for such a principle, a fountain of youth so to speak, in accordance with which the vigor of stellar life should maintain itself from the beginning of time to the end of time; but I think that nothing approaching a satisfactory theory has yet been formulated.[1] The stellar universe seems, from our present point of view, to be slowly 'running down.' The processes will not end, however, when all the heat generable *within* the stars shall have been radiated into an endless space. Every body within the universe, it is conceivable, could have cooled down to absolute zero, but the system might still be in its youth. So long as the stars, whether intensely hot or free from all heat, are rotating rapidly on their axes or are rushing through space with high speeds, the system will remain *very much alive.* Collisions or very close approaches of two stars are bound to occur sooner or later, whether the stars are hot or cold, and in all such cases a large share of the kinetic energy — the energy of motion — of the two bodies will be converted into heat. A collision, under average stellar conditions, should convert the two stars into a luminous gaseous nebula, or two or more nebulæ, which would require hundreds or thousands of millions of years to evolve again into young stars, middle-aged stars, old stars, and stars absolutely cold. So long as any of these bodies retain

[1] Cf. Poincaré (above, pp. 181–183), who reaches a similar conclusion.

motion with reference to other bodies, they retain the power of rebirth and another life. Not to go too far into speculative detail, the general effect of these processes would be the destruction of relative motions and the gradual decrease in the number of separate bodies, through coalescence. Assume further, however, that all existing bodies, widely scattered through the stellar system, are absolutely cold and absolutely at rest with reference to each other; the system might even then be only middle-aged. The mutual gravitations of the bodies would still be operative. They would pass each other closely, or collide, under high generated velocities: there would be new nebulæ, and new and vigorous stellar life to continue through other long ages. The system would not run down until all the kinetic energy had been converted into heat, and all the heat generable had been dissipated. This would not occur until all material in the universe had been combined into one body, or into two bodies in mutual revolution. However, if there are those who say that the universe in action is eternal, through the operation of compensating principles as yet undiscovered, no man of science is at present equipped to prove the contrary." [1]

We cannot tell what the future of science will bring forth; but when we remember that *Homo sapiens* is not so very old, that it has taken millions of years to reach our present position, that science probably offers us surely an unknown, possibly an unlimited, number of years for future development, there is room for a rational expectation that some way will be found to preserve eternally the fruits of human endeavor. The preservation of what is worth while is, I think, necessary for a foundation of ethics. But all scientists are not so optimistic as Mr. Soddy. When we realize that the supplies of coal and oil are limited and that on these at present our civilization depends, when we face the enormous difficulties to be surmounted before atomic energy

[1] Campbell, *op. cit.*, November, pp. 181–182.

can be utilized for industrial purposes, we encounter many problems. It does not take an undue amount of optimism, however, to believe that science will be equal to the task, and that man has before him an exceedingly long period for such use as he may desire. But, however long the time at his disposal on this earth may be, it is extremely doubtful whether it is infinite; so the question remains unanswered as to how his accomplisbments may be eternally preserved. To this problem we shall return. Although an extremely long period for future human evolution seems assured, we must remember that the world as described by science is practically like tbat described by Mephistopheles.

CHAPTER XIII

EVOLUTION

The Elements; the Earth

While this gross physical evolution has been taking place, possibly another kind occurs — an evolution of the chemical elements. "It has long been thought probable that the elements are all built up of some fundamental substance, and Prout's well-known hypothesis that all atoms are composed of hydrogen, is one of the best known examples of this idea. The evidence of radioactivity certainly indicates that the heavy radioactive elements are in part composed of helium, for an atom of the latter appears as a result of many of the radioactive transformations. No direct evidence, however, has been obtained that hydrogen appears as a result of such transformations; but as previously pointed out, helium may prove to be an important secondary unit in the structure of heavy atoms. While we have thus undoubted evidence of the breaking up of heavy atoms, no indication has yet been observed that the radioactive processes are reversible under ordinary conditions. Many investigations have been made to test whether new elements appear in strong electric discharges in vacuum tubes. While some of the results obtained are difficult of interpretation, no reliable evidence has yet been adduced that one element can be transformed into another under such conditions.

"The question of the evolution of the elements has been attacked from another side. Sir Norman Lockyer and others have suggested that the elements composing the star are in a state of inorganic evolution. In the hottest stars the spectra of

hydrogen and helium predominate, but with decreasing temperature, the spectra becomes more complicated and the lines of heavier elements appear. On this view, it is supposed tbat the light elements combine with decreasing temperature to form tbe heavier elements.

"There is no doubt that it will prove a very difficult task to bring about the transmutation of matter under ordinary terrestrial conditions. The enormous evolution of energy which accompanies the transformation of radioactive matter affords some indication of the great intensity of the forces that will be required to build up lighter into heavier atoms. On the point of view outlined in these lectures, the building up of a new atom will require the addition to the atomic nucleus of either the nucleus of hydrogen or of helium, or a combination of these nuclei. On present data, this is only possible if the hydrogen or helium atom is shot into the atom with such great speed that it passes close to the nucleus. In any case, it presumes there are forces close to the nucleus which are equivalent to forces of attraction for positively charged masses. It is possible that the nucleus of an atom may be altered either by direct collision of the nucleus with very swift electrons or atoms of helium such as are ejected from radioactive matter. There is no doubt that under favorable conditions, these particles must pass very close to the nucleus and may either lead to a disruption of the nucleus or to a combination with it. Unfortunately, the chance of such a disruption or combination is so small under experimental conditions that the amount of new matter which is possible of formation within a reasonable time would be exceedingly small, and so very difficult of detection by direct methods. Very penetrating X rays or gamma rays may for similar reasons prove to be possible agencies for changing atoms. Although it is difficult to obtain direct evidence, I personally am inclined to believe that all atoms are built up of positive electrons—hydrogen

nuclei — and negative electrons, and that atoms are purely electrical structures.

"There can be little doubt that conditions have existed in the past in which these electrons have combined to form the atoms of the elements, and it may be quite possible under the very intense electrical disturbances which may exist in hot stars that the process of combination and dissociation of atoms still continues.

"In these lectures, I have tried to give an idea of some modern views of the structure of the atoms and of the great variety of new and powerful methods which have been applied to the attack of this problem in recent years. We have seen that a heavy atom is undoubtedly a complex electrical system consisting of positively and negatively charged particles in rapid motion. The general evidence indicates that each atom contains at its center a massive charged nucleus or core of very small dimensions surrounded by a cluster of electrons probably in rapid motion which extend for distances from the center very great compared with the diameter of the nucleus. Such a view affords a reasonable and simple explanation of many important facts obtained in recent years, but so far only a beginning has been made in the attack on the detailed structure of atoms — that fundamental problem which lies at the basis of physics and chemistry." [1] So, "instead of regarding the hundred or less elements which exist to-day as manufactured, created, once for all time, we rather regard them as existing *because* they have survived. All other forms less stable than those we recognise as elements have been weeded out. Over sufficiently great periods of time the rarity or abundance of an element must be controlled by its degree of instability or stability. Probably for every

[1] Rutherford, "The Constitution of Matter," etc., in *Popular Science Monthly*, August, 1915, pp. 141–142. (Quoted by courtesy of the editor of the *Monthly*.)

stahle atom many unstahle ones could be, even are being, formed. But only the stahle forms can accumulate in quantity and become known to us as ordinary chemical elements. We have seen that the rarest of such in all probability must have a period of thousands of millions of years, while for the more common elements, if they are changing at all, periods of hillions of years may he anticipated." [1]

But, according to some authorities, evolution of matter does not hegin with comhinations of hydrogen atoms, nuclei, and electrons, for here matter is already formed. Atoms of hydrogen, if indeed hydrogen is the primal element, are composed of still simpler entities, electrons, which are units of electricity moving at high rates of speed. According to one guess, their motion through the ether drags along a portion of the ether, and as the ether is supposed to have mass, the atomic weight being one millionth that of hydrogen, the imponderable electron, which is merely a vortex in the ether, thus acquires mass which varies with its velocity.[2]

The question thus arises, What are electrons, what is matter? "To say . . . that the modern physicist has grown so accustomed to the conservation of matter that he is unahle to conceive the contrary, is simply untrue. Whatever may he the case in real fact, there is no question with respect to the possibility of conception. The electrons themselves must he explained somehow; and the only surmise which at present holds the field is that they are knots or twists or vortices, of some sort of either static or kinetic modification, of the ether of space — a small bit partitioned off from the rest and individualised by reason of this identifying peculiarity. It may be that these knots cannot be untied, these twists undone, these vortices broken up; it

[1] F. Soddy, *The Interpretation of Radium*, 1920, p. 163 (By courtesy of John Murray, Esq., London.)

[2] S Herbert, *The First Principles of Evolution*, 1913, p. 43.

may be that neither artificially nor spontaneously are they ever in the slightest degree changed. It may be so, but we do not know; and it is quite easy to conceive them broken up, the identity of the electron lost, its substance resolved into the original ether, without parts or individual properties. If this happened, within our ken, we should have to confess that the properties of matter were gone, and that hence everything that could by any stretch of language be called 'matter' was destroyed, since no identifying property remained. The discovery of such an event may lie in the science of the future; it would be an epoch-making event in the history of science, but no physicist would be upset by it—perhaps not even surprised; nor would any one have good reason to be astonished if the correlative phenomenon occurred, and under certain conditions some knots or strains were some day caused in the ether, which had not been previously there; and so 'matter,' or the foundation of matter, artificially produced. In other words, the destruction and the creation of matter are well within the range of scientific conception, and may be within the realm of experimental possibility."[1] The picture of "the process of inorganic evolution . . . is thus seen to be complete, embracing as it does the first origin of matter, its gradual elaboration into elements, and the building up out of them of the mighty bodies which are known to us as nebulæ, stars, and planets."[2]

All this is pure speculation; electrons, electrically constituted atoms, mechanical models of atoms, the ether, are all ideal conceptions formed to give a mechanical account of the way gross masses of matter behave. They are not objects which can be directly verified by experience; they are on the same plane as

[1] Sir Oliver Lodge, *Life and Matter*, 4th ed., 1907, pp. 32–33. (By courtesy of G. P. Putnam's Sons, New York and London.)

[2] Herbert, *The First Principles of Evolution*, p. 43 (quotations are by courtesy of Messrs. A. and C. Black, Ltd., London). Cf. Soddy, *The Interpretation of Radium*, p. 163.

our hypothesis that reality is mental reality. They do, however, give a rough picture of how the earth and its chemical elements may possibly have been produced. But even in the physical description it is now a world of activity and a world in which something new is continually being created. We can imperfectly see how the earth may have evolved into a molten mass from a primordial chaos.

With its physical evolution it is not impossible that a chemical evolution of the ninety or more elements recognized by modern chemistry progressed with equal steps. Dr. Lawrence J. Henderson gives an interesting account of the processes that would occur in such a molten mass.[1] According to him, this molten earth may be regarded as a single system relatively homogeneous and relatively very unstable, from which infinite varieties of physico-chemical systems have been evolved, — the geographical strata, the ocean, the atmosphere, living organisms. "Relative stability in relative diversity has certainly succeeded relative instability in relative uniformity."[2] This diversity would have been impossible if matter and energy were uniform. It is because our world is composed of about ninety chemical elements which exhibit various manifestations of energy that evolution can occur. Whether all matter and all energy can be ultimately conceived as one is a possibility; but for the actual science of chemistry this has not been accomplished at the present time. Dr. Henderson then agrees with Herbert Spencer in describing evolution as a change from a relatively unstable homogeneity to a relatively stable heterogeneity; but he points out that, unless diversity originally existed, it would be impossible to see how it could have arisen. His account also differs from Spencer's in holding that evolution cannot without qualification be described as a change from the homogeneous unstable to the

[1] Henderson, *The Order of Nature*, 1917, pp. 139 ff.
[2] *Ibid.*, p. 144.

heterogeneous stable, since some heterogeneous systems, as the organic, are very unstable. Yet it is true that from a state that was relatively simple and unstable some systems which are relatively complex and relatively stable have resulted.

There are two points of great interest: first, in order to describe evolution we must say that what was somewhat diverse and unstable changed according to law; second, the process has been that of developing more diverse and more stable systems. Let us for the moment consider the first point. If those physicists are right who hold that the physical world is electrons, th if diversity in the world is to result, even if different chemical elements, which are nothing but different combinations of electrons, are to be formed, it would seem that the electrons must have different properties; for otherwise it is impossible to understand how some electrons should combine to form an atom of hydrogen, others to form oxygen, others to form nitrogen. So, if Dr. Henderson is correct in his assertion that without diversity of chemical elements no evolution can occur, we are driven to conclude that whatever science may decide are ultimate elements must preserve some diversity, however slight. Thus the ultimate elements of science would be an infinite number of individuals, similar but different. They would be hardly distinguishable from monads.

Dr. Henderson shows that, if we continue our description of this evolutionary process, it becomes apparent that a molten mass would exhibit phenomena similar to those which occur in a blast furnace, where "a central metallic core and an outer slag" are formed. "Thus, or otherwise, the lighter elements have come to the surface in relatively great quantities."[1] Conditions that make possible the formation of such a large dense aggregate, the molten earth, involve also the formation of an atmosphere where elements, either free or in combination as

[1] Henderson, *The Order of Nature*, p. 149.

stable gases, were present. Thus the elements, hydrogen, carbon, nitrogen, oxygen, sodium, magnesium, aluminum, silicon, chlorium, calcium, and iron, "elements of low atomic weight" and of an intense and diverse activity, are chiefly concerned with the evolutionary processes on the earth. The most important of these elements are hydrogen, carbon, nitrogen, and oxygen, which surely existed from very early times and certain combinations of which—water and carbon dioxide—have long been present. As the earth cooled, water began to condense from the atmosphere. Before this the igneous rocks, torn and twisted by volcanic influences, were formed. The action of water on these rocks "is the most powerful and most universal agent in moulding the surface of the earth. . . . In the course of the meteorological cycle the movements of water became canalized. Streams, lakes, and the ocean assumed a somewhat definite form, water began to penetrate the débris resulting from its own action, and from that of dissolved carbonic acid, to set this in motion, and thus in certain localities to form deposits. Some of these have become strata, others, with the help of further agencies, earth and soil. And at length nearly everything that meets the eye, except life and the products of life, has been moulded into its form by the action of water and carbonic acid.

"The only other great event in the history of the earth — but of this we have no knowledge — is the beginning of the process of organic evolution. Yet if the meteorological processes have multiplied a thousand fold the evolution of systems, organic evolution has again multiplied these in a like proportion. The elements here chiefly involved are, once more, hydrogen, carbon, nitrogen, and oxygen." [1]

Before passing to the discussion of organic evolution we should mention certain supplementary aspects of inorganic evolution. One of the chief results of the action of water is the

[1] Henderson, *The Order of Nature*, pp. 151–153.

wearing away of the dry land; it is held that twenty million years would wear away the continent of North America if nothing intervened. But the crust is always in motion, heaving and falling. After a deposit has been made in the sea, this deposit is often pushed up again; so that the process is the building-up of continents and the wearing away of them. Partly as a consequence of these changes in the crust of the earth, there have been marked changes in climate, accompanied by advances and retreats of the polar ice mantle, which, by radically changing the environment, have had great influence in determining the course of organic evolution. "Whenever," says Lull, "it has been possible to connect cause and effect, the immediate influence is found to be generally one of climate, back of which lies, as the main cause, earth shrinkage and a consequent warping of the crust, with the elevation and spread of the lands and the formation of mountain ranges. In addition to this mundane cause, there are the complex rhythms in solar energy and the consequent variation in the amount of solar-derived heat. For example, the most generally accepted single cause of the last or Pleistocene glacial period is the great continental elevation which formed the Cascadian revolution, but, so far as our knowledge goes, that would not account for the successive advances and retreats of the ice mantle, with the attendant climatic variation, and some other factor such as the rhythms of solar energy must be invoked as of supplemental influence."[1]

We have seen that a few elements, and especially the four organic ones, have played the chief part in evolution. It is interesting to note that two distinct aspects of evolution become apparent. One, if I understand Dr. Henderson, is that, according to Gibbs's formulæ, systems relatively stable must develop;

[1] R. S. Lull, "The Pulse of Life," in *The Evolution of the Earth and its Inhabitants*, ed. Lull, 1920, pp. 109–110. (By courtesy of the Yale University Press, New Haven.)

the other is that certain chemical elements are given which furnish material for very diverse, complex, yet stable systems. That both these conditions of evolution should have occurred by chance is impossible. We must regard the environment as a preparation for the formation of stable, diverse systems like the organic. Nature, then, appears teleological, not in the sense of embodying conscious purpose, but in the sense of being more than the mere mechanical, though at the same time as being subject to mechanical laws. "There is, in truth, not one chance in countless millions of millions that the many unique properties of carbon, hydrogen, and oxygen, and especially of their stable compounds water and carbonic acid, which chiefly make up the atmosphere of a new planet, should simultaneously occur in the three elements otherwise than through the operation of a natural law which somehow connects them together. There is no greater probability that these unique properties should be without due cause uniquely favorable to the organic mechanism. These are no mere accidents; an explanation is to seek. It must be admitted, however, that no explanation is at hand."[1] But Dr. Henderson does attempt some explanation of the connection; it is a teleological one:

"The whole history of thought does but prove the justice of this conclusion. We may progressively lay bare the order of nature and define it with the aid of the exact sciences. Thus we may recognize it for what it is, and now at length we clearly see that it is teleological. But we shall never find the explanation of the riddle, for it concerns the origin of things. Upon this subject clear ideas and close reasoning are no longer possible, for thought has arrived at one of its natural frontiers. Nothing more remains but to admit that the riddle surpasses us and to conclude that the contrast of mechanism with teleology is the very foundation

[1] Henderson, *The Fitness of the Environment*, 1913, p. 276. (By courtesy of The Macmillan Company, New York.)

of the order of nature, which must ever be regarded from two complementary points of view, as a vast assemblage of changing systems, and as an harmonious unity of changeless laws and qualities working together in the process of evolution.

"This conclusion rests upon an analysis which may now be recapitulated in its most summary form.

"First, the characteristics of systems (phases, components, activities, etc.) are universal conditions of all phenomena, except the infra-molecular. They do not depend upon the peculiarities of the numerous varieties of matter, and they are changeless.

"Secondly, the properties of matter are so distributed among the elements that three elements possess a unique ensemble of unique characteristics, — maxima, minima, and other singular properties. But this pattern in the properties of matter is also a universal condition of phenomena. It seems to be quite unmodified by the characteristics of systems, in that, like such characteristics, it is changeless.

"Therefore we cannot conceive these two abstract qualities of the universe as dependent, in any physical sense, upon each other. Conceived by Gibbs to be originally independent, they are alike unmodified in time. It is therefore at present impossible to imagine that there should be, in the mathematical sense, a functional relationship between them. . . .

"It cannot be that the nature of this relationship is, like organic adaptations, mechanically conditioned. For relationships are mechanically conditioned in a significant manner only when there is opportunity for modification through interaction. But here the things related are supposed to be changeless in time, or, in short, absolute properties of the universe.

"According to the theory of probabilities this connection between the properties of matter and the process of evolution cannot be due to mere contingency. Therefore, since

physico-chemical functional relationship is not in question, there must be admitted a functional relationship of another kind, somewhat like that known to physiology. This functional relationship can only be described as teleological." [1]

This interpretation of the "fitness of the environment" is not, I suppose, universally accepted. For instance, Mr. J. Arthur Thomson refers to it as at present a "pious anticipation."[2] However this may be, it is significant, I think, that such an extraordinarily well-equipped scientific mind as Dr. Henderson's should feel compelled to posit a teleological significance in the evolutionary process.

There are other difficulties in stating cosmic evolution from a mechanical point of view to which I should like to call attention. Suppose we set out with the theory that the world is electrons in motion; then we must suppose that the original nebula, or whatever the world comes from, contains in the laws of the motions of these electrons the future aspects of the world, and that all this would be recognized by an omniscient mind. The primal stage is, then, just as diverse and complex as the resulting one; no real change or evolution has taken place. All that has really happened is a different distribution of the elements at different times; one stage is actually no more complex or diverse than another. But from the human point of view evolution seems to be a change from something that is relatively simple to something that is relatively complex. Such a description involves a valuation of the result, a statement that the more complex, the more diverse, is more valuable from the human point of view. It is really a teleological conception.

Moreover, since cosmic evolution occurs in time, it is rather difficult to understand why evolution should not have ceased; for past time is infinite, whereas matter and motion are usually

[1] Henderson, *The Order of Nature*, pp. 208–211.
[2] Thomson, *The System of Animate Nature*, 1920, i, 73–74.

regarded as fixed quantities, and motion in the form of heat tends to become unavailable. There is a similar difficulty in understanding the evolution of chemical elements. Uranium undergoes a slow process of decay; 4,500 million years are required for one half of its atoms to disintegrate,[1] and as yet no process of building up elements has been observed. Why, then, is there any uranium in the universe? Mr. Bertrand Russell suggests that there may be cycles of building up and breaking down, and that what we are now observing is a cycle of disintegration.[2]

So, looking at the process of inorganic evolution, we may form a vague picture of the earth as having progressed by slow changes from a nebulous mass according to laws that are known in part. We cannot follow all the steps; we do not know all the laws. When we attempt to generalize a statement of this process we can only assert that the relatively unstable, relatively homogeneous, has developed into the relatively stable, relatively heterogeneous. From whatever the process started, this original something must have had diversity. The process, however, has no meaning except from the point of view of value to man, since it can be defined only in teleological terms. Indeed, the process itself, if we follow Dr. Henderson, scientifically points to something teleological.

[1] Bertrand Russell, *The A B C of Atoms*, 1923, p 110
[2] *Ibid.*, p. 113

CHAPTER XIV

THE BEGINNINGS OF ORGANIC EVOLUTION

In our description of inorganic evolution we have now reached the point where conditions on the earth are such that life can exist. It is apparent that life is in some way associated with physico-chemical systems. The next point to consider is how these organic systems could have originated. It may as well be said at the outset that there is no theory which is generally accepted; all views as to the origin of man are pure speculations, attempts to picture some possible way in which such an organic system could have been evolved or, failing this, to state some conceivable way by which life could have reached the earth. They all agree on the fact that protoplasm is somehow associated with the phenomena of life, that it is the material vehicle of life. No attempts have as yet succeeded in reproducing live protoplasm by chemical methods, and this is not surprising since no one knows what live protoplasm is. Any chemical method of attack of course destroys it as living substance.

But we do know something about protoplasm. For example, we know that it is composed of certain substances in combination the elements of which can be determined: (1) proteins; (2) carbohydrates; (3) fats.[1] Including other elements that are present and may also be necessary to the building-up of proteins, we have, according to Verworn and Osborn, the following elements contained in all cells:

[1] Max Verworn, *Allgemeine Physiologie*, 6th ed., 1915, p. 143; L. J. Henderson, *The Fitness of the Environment*, 1913, pp. 191–213; E. B. Wilson, *The Physical Basis of Life*, 1923, pp. 8–10.

	Symbol	Approximate Atomic Weight
Hydrogen	H	1
Oxygen	O	16
Nitrogen	N	14
Carbon	C	12
Phosphorus	P	31
Sulphur	S	32
Potassium	K	39
Magnesium	Mg	24
Calcium	Ca	40
Iron	Fe	56
Sodium	Na	23
Chlorine	Cl	35[1]

To this list Osborn adds

Silicon	Si	28[2]

and Verworn gives, as present in many cells, not only Silicon but also

Fluorine	F	19
Bromine	Br	80
Iodine	I	127
Manganese	Mn	55
Aluminum	Al	27[3]

Osborn[4] adds a number of other elements that are sometimes present.

The most important of these elements are of course oxygen, hydrogen, nitrogen, and carbon. These are found in other celestial bodies and in the sun; they are of relatively light atomic weight, are very active, and have strong attractive power.[5] It may be supposed that the very powerful attraction of oxygen and carbon resulted, at very early stages of the evolution of the earth, in forming carbon dioxide and that the like properties of

[1] Verworn, *op cit*, p 108

[2] H F. Osborn, *The Origin and Evolution of Life*, 1916, pp 59–67.

[3] Verworn, *op. cit*, p 109

[4] Osborn, *op cit*, p 66

[5] Henderson, *The Fitness of the Environment*, pp. 267–271; *The Order of Nature*, p 155

oxygen and hydrogen resulted at early stages in the formation of water. Thus conditions in the primordial environment were furnished suitable for life.

If life originated on the earth, we must suppose that certain more complicated systems occurred through complex compounds of hydrogen, oxygen, and carbon, to which the addition of nitrogen gave the protein substances common to all forms of life.[1] Thus Haeckel holds that the synthesis occurred in sea-water, where all the necessary elements are present; that in the sea-water specialized colloidal substances were formed, from which, by further combinations, life itself evolved.[2] Osborn, following Professor W. J. Gies, thinks that these compounds may have originated either in pools of water of a suitable temperature or in moist earth.[3] According to Pflüger, proteins are derived from cyanogen compounds. Cyanogen arises in incandescent heat; therefore the synthesis of the elements necessary to produce proteins must have occurred in very early times at a very high temperature.[4]

But the difficulty, perhaps the impossibility, of solving the question as to the formation of proteins, whether in the laboratory or by induction from the history of the earth, has led many to think that 'life is eternal, that it is coëxistent with matter. The ultimate origin of life should not, therefore, be searched for any more than the origin of energy or matter: it exists. Its origin on the earth is to be explained, according to Lord Kelvin and Helmholtz, by the agency of meteorites bearing germs of life from other cosmic bodies.[5] In the opinion of Svante Arrhenius, life was brought to the earth through the force of radiation, a theory which even Jacques Loeb thinks deserves serious con-

[1] Verworn, *op. cit.*, p. 111; Osborn, *op. cit.*, pp. 67–71.
[2] S. Herbert, *The First Principles of Evolution*, 1913, pp. 47–48.
[3] Osborn, *op. cit.*, pp. 35, 38–39.
[4] Herbert, *op. cit.*, pp. 47–48.
[5] Herbert, *op. cit.*, p. 47.

sideration.[1] And Professor Preyer holds that the inorganic is evolved from the organic, that the originally molten globe was alive and the inorganic evolved as a sort of incumbrance or slag.[2] The unproved belief of many scientists is well stated in the words of Mr. Julian S. Huxley: "Of the origin of life we have, in the nature of things, as yet no definite knowledge; but everything points towards this conclusion—that during the gradual cooling down of this planet a state of affairs arose which inevitably led to the production, in that cosmic laboratory, of molecules which were alive in that they had the power of reproducing themselves and reacting to stimuli, and gave rise to the living things that we see to-day; in other words, that there has not only been an evolution of all living things from one common ancestor, but of all life from not-life."[3]

There is another, and an exceedingly interesting, attempt to reduce reality to a unity and to describe the origin and nature of life. This involves the concept of energy more emphatically than that of matter. Dr. Osborn is one of its chief exponents. He holds that the origin and evolution of life "may be rewritten in terms of invisible energy, as it has long since been written in terms of visible form. All visible tissues, organs, and structures are seen to be the more or less simple or elaborate agents of the different modes of energy. One after another special groups of tissues and organs are created and coördinated—organs for the *capture* of energy from the inorganic environment and from the life environment, organs for the *storage* of energy, organs for the *transformation* of energy from the potential state into the states of motion and heat. Other agents of control are evolved to bring about a harmonious *balance* between the various organs

[1] Loeb, *The Organism as a Whole*, 1916, pp. 33–39.
[2] Herbert, *op. cit.*, p. 47.
[3] Huxley, "Biology," in *The Outline of Science*, ed. J. A. Thomson, 1922, iii, 675. (Quotations are by courtesy of G. P. Putnam's Sons, New York and London.)

and tissues in which energy is *released,* hastened or *accelerated,* slowed down or *retarded,* or actually arrested or *inhibited.*"[1] An explicit and illuminating version of such a theory is given by Dr. Frank C. Eve, who begins by defining certain terms that are necessary to the understanding of his view:

"First, what do we mean by Energy? It is defined as 'the capacity to do work'; but in reality we do not know what it is. Some think that matter may be a manifestation of energy. At any rate, energy has now been measured in units, or *quanta,* so presumably we may regard it as an entity and not as a mere state of matter. . . .

"I shall constantly have to use two new words, Katergy and Anergy. For the comprehension of this paper it is *essential* to remember their meaning—briefly, downflow and upflow of Energy.

"By *Katergy* (Kata-energy) I mean 'the flow of energy to a lower potential or level,' whatever the kind of energy may be. When Katergy occurs, work is done, heat is produced, and the energy becomes less available.

"By *Anergy* (Ana-energy) I mean 'the flow of energy to a higher potential,' regardless of what kind of energy it is.

"Katergy always occurs when possible. Hence Anergy never occurs unless, as an episode in Katergy, part of the energy is compelled to flow 'uphill' by some device such as chlorophyll. . . .

"*Law of Degradation of Energy* (Law of Katergy).—This states that energy is constantly tending to flow to a lower potential, whereby it turns itself into lower and less available forms of energy, and eventually into low-temperature heat. . . .

"The laws of Energy, for biological purposes, can be grouped, I think, under these three heads:—

"1. *The Law of Metergy*—that energy can be changed from

[1] Osborn, *op. cit.*, p. 17 (quotations are by courtesy of Charles Scribner's Sons, New York). Cf. Benjamin Moore, *Biochemistry, a Study of the Origin, Reactions, and Equilibria of Living Matter,* 1921.

one form into an equivalent amount of another form, but cannot be created or destroyed. . . .

"2. *The Law of Katergy*—that energy tends constantly to degrade itself into less available forms of lower potential, and eventually into low-temperature heat. We can now express this as, 'Katergy tends insistently to occur'. . . .

"3. *The Law of Ana-katergy*—'Katergy may encounter an anergy transformer which compels *part* of it to flow simultaneously to a higher potential.'

"This combined simultaneous process is *Ana-katergy*, and the greatest example of it is the green leaf, which katergizes sun-light, but at the same time—by the agency of chlorophyll—anergizes part of the light-energy into the chemical energy of starch. . . .

"As this conception of ana-katergy has not been formulated before, I must give three instances of it—a mechanical, a physical, and a chemical instance.

"1. The hydraulic ram. . . . A large pipe, led from a stream, is the source of katergy. A small pipe leads from the apparatus to a cistern of a country-house high above the valley. Thus, without fuel or human regulation, the potential energy of the water in the stream is prevented from total katergy and a portion of it is automatically turned into anergy. The combined simultaneous process is ana-katergy.

"2. A physical instance of ana-katergy.—When the sun shines on the sea, the water surface is warmed and turned into an invisible vapor, which happens fortunately to be lighter than air. This ascends, and condenses in the cool upper air into a cloud of droplets of water, which has thus been raised against the force of gravity and thereby been given potential energy. That is to say, anergy has occurred in a process of katergy; the energy of sunlight has been degraded, but, by help of a device, part of it has been simultaneously turned into anergy. . . .

"3. . . . Professor Moore exposed to sunlight a soup-plate of water, containing sodium nitrate (1 in 10,000). After two hours, he found by test-papers that the nitrate had been turned into nitrite, which contains 21,000 more units of potential energy per gram-molecule than the nitrate. This energy had been put into it by the sunlight. . . . Moreover, the nitrite molecule is an unstable one, and will slowly oxidize back into nitrate — perhaps in a single night.

"Hence we see that the nitrate molecule behaves exactly like a minute plant, in that it katergizes sunlight, with the simultaneous transformation of part of the energy into chemical anergy. Further, it liberates oxygen in the light, and absorbs oxygen in the dark, by a miniature respiration — just like a plant. Or, the nitrate molecule may be regarded as analogous to chlorophyll, because they are both anergy transformers of sunlight, converting deënergized chemical bodies into energized compounds — nitrites or starch, respectively.

"If, at the dawn of life, a nitrate were associated with a pigmented slimy carbohydrate colloid, to give substance and coherence and an opportunity of growth, and to take advantage by coupled reactions of the chemical energy of the nitrite formed by sunlight, then we should begin to see possibilities of a primitive attempt at vegetable life.

"Since writing this, the fundamental importance which I attached to this nitrate experiment has been confirmed by some remarkable experiments by Professor Baly and his coworkers at Liverpool (1922).

"It was already known that sunlight could very slowly turn carbonic acid into sugar (*via* formaldehyde). Baly found that, if potassium nitrate was present, this sugar formation was very rapid, and that complex alkaloids were also formed, and — still more wonderful — that even proteids were produced. In

other words, these complex 'organic' chemical bodies, which hitherto had been regarded as marvelous achievements, possible only to the living cell, were formed automatically, when sunlight acted on carbonic acid and a nitrate.

"These experiments (when confirmed) seem to me of enormous importance in five directions, at least:—

"1. They obliterate the distinction between organic and inorganic chemistry.

"2. They remove a whole block of difficulties in our attempts to explain Life and its origins by laws already known.

"3. They indicate that complex 'organic' carbon compounds must have been present in the sea long before the origin of Life, which is thereby easier to imagine.

"4. They are instances of *growth*, though without form or visibility or coherence.

"5. These highly anergized chemical bodies (soluble carbohydrates and proteids) would be excellent foods. . . .

"The Dawn of Life would have consisted in sunlight finding by evolution better and better means of ana-katergy — at first inorganic, then insensibly becoming organic. . . .

"If such a katergic theory of Life be accepted, an important and illuminating addition can at once be made to Darwin's law of evolution by survival of the fittest. Fittest for what? Fittest for the most efficient katergy of their environments. In the case of plants, it is the most efficient ana-katergizers of sunlight energy which survive; in the case of animals, fungi, and bacteria, the most efficient katergizers of the chemical energy anergized by plants. I have given a few instances of this. It seems to me a direct corollary of my main doctrine, that living things are the evolved materializations of the laws of katergy. In other words, that they are the evolved channels carved for

itself by katergy. Energy will naturally flow through the widest, steepest channels; the others will starve. The best katergizers will survive."[1]

If all evolution is in accordance with the laws of energy, a corollary results: since energy, whenever it exhibits itself at all, flows into less available form, and since all work ceases when there is no difference in potential, eventually a state of cosmic equilibrium must be reached much like that described by Campbell. The ultimate result of evolution is the same on both theories. Now, if one uses the word purpose or striving instead of the word katergy, and harmony instead of equilibrium, then one can equally well describe evolution after the manner of Royce, as activity striving always for complete harmony and adjustment.

Perhaps the scientific view of such guesses as to the origin of life is best expressed in the words of Dr. Henderson: "Apart from the imperfect generalization of natural selection and the rudimentary beginnings of a science of heredity, we still have but the vaguest ideas concerning the development of living things as products of nature. And regarding their origin we have no ideas at all"[2]

In view of such conflicting opinions, we must admit that the origin of life is shrouded in mystery. But, in spite of this ignorance, there is a vast amount of indirect evidence which appeals very strongly to some minds in favor of the theory that organisms are of the same nature as inorganic substances and were produced on the earth by the same processes that produced inorganic systems. The interpretation of these organic processes

[1] Frank C Eve, "In the Beginning an Interpretation of Sunlight Energy," in *Atlantic Monthly*, May, 1923, pp 661–677 *passim* (quoted by courtesy of the author and of the Atlantic Monthly Press, Inc , Boston) Cf M O Forster, "The Laboratory of the Living Organism," British Association, *Report*, 1921, pp 36–55

[2] Henderson, *The Order of Nature*, p 118

after they are formed, the question whether they are ruled by mechanistic or teleological categories, is an even more difficult question; but it is probably fair to say that the majority of those who accept the conclusion that an organism is of the same nature as a physico-chemical system hold that only a mechanistic interpretation is possible. That this conclusion is correct I should of course deny. For the moment, however, we are concerned not with criticism but with a survey of the evidence and its interpretation.

It would in many ways be more natural to continue our discussion by examining the theory of organic evolution; but the interpretation of this theory rests on so many observations regarding the fundamental nature of organisms that it is necessary to postpone discussion for the present and make an imperfect and hurried survey of what biology tells us about these interesting objects.

As an observed fact, we find that an organism is always produced from another organism; in the higher animals by the union of two cells, one from the father, one from the mother. In the lower organisms the coalescence of cells is probably not a necessary process; an organism may be produced by the mere division of a cell or by the separation of a cell or a number of cells from the parent.[1] Now, this fact that an organism is always produced from a living cell or cells is held to be true both of the individual development of the organism and of its historical evolution. So Mr. E. B. Wilson regards it as very remarkable that these two independent lines of research have met in the same point, producing the greatest biological generalization since Darwin. The "*omnis cellula e cellula*" of Virchow is, he believes, true of organic evolution and of organic development; it is true of all life so far as observed on the earth.[2] It is therefore

[1] Raymond Pearl, *The Biology of Death*, 1922, pp. 30–42.
[2] Wilson, *The Cell in Development and Inheritance*, 2d ed., 1910, pp. 1–2, 10

impossible to understand an organism without some knowledge of the cell.[1]

"The old picture of a cell was that of a little drop of living matter with a kernel or nucleus, and sometimes with an enclosing wall. But the revelations of the microscope have made this picture obsolete. We have to think of a more or less unified minute area of great chemical diversity, with complex particles and unmixing droplets restlessly moving in a fluid. In the centre of this whirlpool, with its flotsam of reserve-products and waste-products, there floats the nucleus, a little world in itself. Inside its membrane, through which materials are ever permeating out and in, there are readily stainable nuclear bodies or 'chromosomes,' usually a definite number for each species. And each 'chromosome' is built up of bead-like 'microsomes' strung on a transparent ribbon. . . . Inside the nucleus there may be a nucleolus or more than one, and outside the nucleus there is a minute body called the centrosome, which plays an important part in the division of the cell."[2] The cell is therefore a bit of living matter, a bit of protoplasm, usually consisting of nucleus and surrounding cytoplasm. Since different parts of the cell can be distinguished by the microscope, since they stain differently, since, as we shall see, they behave differently, we must suppose that cells are composed of protoplasms rather than of a single uniform protoplasm. Since species of organisms differ and are intolerant of the protoplasm of other species, the protoplasms of species must differ; and, since individuals are all slightly different, there must apparently be as many kinds of protoplasms as there are individuals. Since individuals have different tissues,

[1] Verworn, *Allgemeine Physiologie*, 1915, p. 50. Cf. L. L. Woodruff, "The Origin of Life," in *The Evolution of the Earth and its Inhabitants*, ed. R. S. Lull, 1920, especially p. 87.

[2] "The Wonders of Microscopy," in *The Outline of Science*, ed J. A. Thomson, 1922, ii, 306. See also E. B. Wilson, *The Physical Basis of Life*, 1923.

it would seem as if cells all differed and consequently there must be innumerable protoplasms.[1]

As we have already noticed, organisms have several methods of reproduction. In some cases a single cell is produced, like a bud, which separates and forms a new individual. In other cases a group of cells splits off and forms the new organism. But the most common mode of reproduction of many-celled organisms is by the fusion of two special cells of the parent organisms, the germ-cells. Before proceeding to a description of the division of germ-cells, let us pause to consider an obvious yet very interesting fact about organisms, which is that, although individuals perish, yet organisms do not — that possibly cells are immortal. Dr. Raymond Pearl sums up much evidence which tends to show that single cells and even groups of cells under proper conditions are potentially immortal, that death in multicellular organisms comes about either by accident or by a lack of coordination between groups of cells, with the result that the whole finally breaks up. The evidence for the immortality of cells includes researches like those of Woodruff, who has cultivated the *Paramecium* for over thirteen years. "In a recent letter Dr. Woodruff says: '. . . But the culture is still going on as well as ever and is at approximately the 8500th generation — 13½ years old! on May 1, 1915 (just 8 years old) it was at the 5071st generation.' If in 8500 generations — a duration of healthy reproductive existence which, if the generation were of the same length as in man would represent roughly a quarter of a million years in absolute time — natural death has not occurred, we may with reasonable assurance conclude that this animal is immortal."[2]

[1] Jacques Loeb, *The Organism as a Whole*, ch. iii; Leo Loeb, "The Scientific Investigation of Cancer," in *Scientific Monthly*, September, 1916, pp. 209–226; Verworn, *Allgemeine Physiologie*, p. 667.

[2] Pearl, *The Biology of Death*, pp. 30–31. (Quotations are by courtesy of the J. B. Lippincott Company, Philadelphia.)

Moreover, it has been shown by a long series of researches that groups of cells from higher organisms may, if cultivated in a suitable environment, live indefinitely. Thus Carrel kept a bit of connective tissue from the heart of an embryo chick alive for nine years and on the 17th of January, 1921, it was still just as active as ever.[1] Leo Loeb has been able to keep cells of tumors alive indefinitely by transplanting them to new hosts. As tumors are merely transformed tissue-cells, all tissues may thus be held to be potentially immortal.[2] Indeed, life must be regarded as continuous, as renewed from generation to generation; so that any organism existing to-day must trace its ancestry back in a continuous line to the first origin of life, wherever this occurred.[3] If life is to be considered as eternal, then our ancestry is infinite. If life originated from the inanimate, then the systems from which it originated were in turn the results of prior systems; likewise from this point of view our individual existence in a sense stretches back to the infinite past. So we can begin to understand how Emerson is justified in calling an individual an "encloser of the infinite"; we are beginning to see how character must be considered *sub quadam æternitatis specie*.

Now, it is man that especially interests us. Let us trace in a little more detail, but very roughly, the development of such an organism. We know that it starts from the juncture of two cells, the sperm and the ovum. The nuclei of these two cells unite and changes begin; the chromosomes split lengthwise into two equal or nearly equal parts; sometimes they twist about each other, but eventually half goes to one spindle of the cell, half to the other, whereupon the cell divides into two other cells. These cells again divide, and the process continues until the complete organism is developed. But with the division, specialization of the cells goes on; different tissues are formed, from these come different organs, and finally the complete organism, which is a

[1] Pearl, *op. cit.*, pp 62–63. [2] *Ibid.*, pp. 64–67. [3] *Ibid.*, p. 42.

cell-community unified by the nervous system and by chemical messengers — secretions of the glands — into an organic whole.

Now, a very significant specialization and separation of cells occurs very early in the history of the divisions of the impregnated ovum. Certain direct descendants of the original germ-cells are set apart, which eventually give rise to new germ-cells. "Reduced to a formula we may say that the fertilized ovum (united germ cells) produces a soma, and more germ cells. The soma eventually dies. Some of the germ cells, prior to that event, produce somata and germ cells, and so on in a continuous cycle which has never yet ended since the appearance of multicellular organisms on the earth."[1]

The most striking feature of this division of the cell is that the nucleus resolves into a definite number of chromosomes, and this number differs for each species. Thus the parasite worm, *Ascaris megalocephala univalens*, has 2, the crustacean *Artemia* 168, *Salamandra maculata* 24, the sea-urchin 36.[2] We have seen that very early in the history of the organism certain cells are set off to form new germ-cells. In the adult organism these cells result from the fission of the cells of the reproductive glands and are called gametes. In reproduction these gametes unite and form a new cell, the zygote. We have seen that the number of chromosomes is constant for each species. So, if the germ-cells that are formed from the parents contain the same number of chromosomes as the parents, it would seem that the resulting cell, the zygote, would contain twice as many chromosomes as are characteristic of the species. But after the cells that are formed in the reproductive glands separate from the parent cells they divide again and in some way lose half of their chromosomes; so the gametes thus formed have only one half the number of chromosomes characteristic of the species. Therefore

[1] Pearl, *op. cit.*, p. 40.
[2] E. B. Wilson, *The Cell in Development and Inheritance*, pp. 206-207.

when the male and female gametes unite the requisite number of chromosomes results.[1] The fusion of the spermatozoon and the ovum is the beginning of the new life of the individual. By a process of cell-division repeated many, many times, the complete new cell-community results. So, looking at the organism as the product of cell-division and regarding the activity of these cells as constituting the various activities of the organism, Virchow emphasized the fact that the organism is really a cell-community and that the way to understand it is to study the separate units of which it is composed. When the cells are joined together into such a community as the human body, there is of course specialization of function. Some cells digest food, others become muscle tissue, others sense organs, others neurons. But they are all cells, and the laws of cell-life apply to these specialized cells as well as to the isolated ones. To some of the problems concerning the functions of cells we must now turn. We must ask, What is a live cell, what is a simple organism?

If this question could be answered, we should of course know what life is, and this at present we do not know; but certain characteristics of the organism we are able to enumerate. It grows, it maintains itself through metabolism, it reproduces itself, it reacts to stimuli (is irritable), it learns by experience, it acts as a whole. Even if these characters can be shown to belong to the non-organic world, it is certain that an organic being has more of them and in more developed form than we find in the inorganic world. As Jacques Loeb well says, "The constant synthesis then of specific material from simple compounds of a non-specific character is the chief feature by which living matter differs from non-living matter." [2]

Let us try to form a rough physical picture of what an organ-

[1] For an excellent description of this process, see T. H. Morgan, *A Critique of the Theory of Evolution*, 1916, pp. 89–99.

[2] Loeb, *The Organism as a Whole*, p. 29. (Quotations are by courtesy of G. P. Putnam's Sons, New York and London.)

ism is, conceived in material terms. Sir Michael Foster used to say, "A living thing is a vortex of chemical and molecular change."[1] So that, "if we imagine a single living cell of the simplest kind living in a fluid nutritive medium, and if we suppose its body and surroundings so magnified that the single molecules and atoms were respectively of the size of cannon and rifle balls, the boundary between cell and medium would represent a battlefield, on which a heavy bombardment is constantly taking place. The rain of shot of food and oxygen molecules penetrating into the cell from the medium, would produce an explosion in the existing ammunition depots, now at one point, now at another, creating great breaches through which new masses of shot would reach the interior. The fragments of these exploding molecules would be flung out here and there into the medium and would stem, now at this, now at that point the besieging masses of shot. In this wild confusion on the whole boundary line between cell and medium there can be no question of rest or even equilibrium at any point."[2] This vortex persists, and while doing this it exhibits certain characters different — at least at first sight — from what occur in inorganic nature. But are these processes really different? In this connection Woodruff says, "The study of protoplasm has given no reason for abandoning the productive *working hypothesis* that life phenomena are an expression of a complex interaction of physicochemical laws which do not differ fundamentally from the so-called laws operating in the inorganic world."[3] But we are unable to give an explanation of life in these terms at present, and "the twentieth century finds relatively few

[1] Quoted by William Bateson, *Problems of Genetics*, 1913, pp. 39–40.

[2] Verworn, *Irritability*, 1913, pp. 68–69. (By courtesy of the Yale University Press, New Haven.)

[3] L. L. Woodruff, "The Origin of Life," in *The Evolution of the Earth and its Inhabitants*, ed. Lull, 1929, pp. 86–87. (By courtesy of the Yale University Press.)

representative scientists who really expect a scientific explanation of life ever to be attained." [1]

Thus "the study of the cell has on the whole seemed to widen rather than to narrow the enormous gap that separates even the lowest forms of life from the inorganic world." [2] Such a position is conservative, but it may lead to an extreme humility like that of T. H. Huxley, who said, "In ultimate analysis everything is incomprehensible, and the whole object of science is simply to reduce the fundamental incomprehensibilities to the smallest possible number." [3]

On the other hand, we have a host of writers, of whom perhaps Jacques Loeb and Max Verworn are typical but extreme, who insist that life must be interpreted in physico-chemical terms; and many others, like Dr. Hans Driesch, Mr. J. Arthur Thomson, and Dr. J. S. Haldane, who insist that life cannot be so interpreted. Since I believe that a statement of natural law and external reality is possible which combines these conflicting views and makes intelligible many of the seemingly insoluble problems of science, and which is of the greatest value to an intelligible psychological account of character, it will be necessary for us to become somewhat familiar with this scientific discussion. Perhaps the simplest and briefest way to accomplish this end will be to select certain important functions of the cell, the simple organism, and point out how some scientists attempt to reduce these functions to physico-chemical terms while others assert that this is impossible.

[1] Woodruff, "The Origin of Life," p. 95.

[2] E. B. Wilson, *The Cell in Development and Inheritance*, p. 434 (quotations are by courtesy of The Macmillan Company, New York). Cf. his *Physical Basis of Life*, p. 46.

[3] Huxley, "Darwinia" (*Collected Essays*, 1893, ii, 165), quoted by Woodruff, "The Origin of Life," p. 95.

CHAPTER XV

FUNCTIONS OF ORGANISMS

A. Growth and Metabolism

The surface of a living cell has the characteristics of a semi-permeable membrane.[1] Water gives the cell its fluidity, and the process of metabolism regulates, in part at least by osmotic pressure, the content of water in the cell. By absorbing water and food cells grow and finally divide. It is this process of division that causes growth in multicellular organisms. The process of division can, however, be imitated by chemical preparations. Thus Leduc has shown that a bit of calcium chloride placed in a colloidal solution absorbs water, forms a membrane, and grows in segments much like a living organism. By other chemical preparations he imitated division.[2] So Verworn holds that cell-division is merely a mechanical process involving the relations of the volume of the cell to its surface tensions.[3] The mere external fact of growth, then, does not seem to be an exclusively organic function.

But many scientists, while giving full force to such observations, hold that as yet no mechanical account of the fundamental process of growth and division has been given, and some maintain that it cannot be given. Bateson says we can see the symptoms of division, "but we have no surmise as to the nature of the process by which the division is begun or accomplished"; yet it is premature to assert that such division is not mechan-

[1] Max Verworn, *Allgemeine Physiologie*, 1915, pp 134–135

[2] Stéphane Leduc, *Théorie physico-chimique de la vie*, 1910.

[3] Verworn, *Allgemeine Physiologie*, pp 145–151, 674–695.

ical.[1] Hans Driesch, from observations which we shall mention when we consider development, holds that division cannot be mechanical, "for a machine, typical with regard to the three chief dimensions of space, cannot remain itself if you remove parts of it or if you rearrange its parts at will."[2] E. B. Wilson remarks, "At present we can only admit that none of the conclusions thus far reached, whether by observation or by experiment, are more than the first *naïve* attempts to analyze a group of most complex phenomena of which we have little real understanding."[3] And even Loeb says, "The fact that the living cell grows after taking up food has given rise to curious misunderstandings. Traube has shown that drops of a liquid surrounded with a semipermeable membrane may increase in volume when put into a solution of lower osmotic pressure. This has led and is possibly still leading to the statement that the process of growth by a living cell has been imitated artificially. Only one feature has been imitated, the increase in volume; but the essential feature of the process in the living cell, *i.e.*, the formation of the specific constituents of the living cell from non-specific products, has of course not been imitated."[4]

Growth, then, depends on metabolism,[5] and metabolism consists in the power of absorption of specific substances by the organism and the elimination of waste products caused by its activities. For animals, constructive metabolism consists largely in the absorption of food and water and in the securing of a sufficient amount of oxygen from the air. So the question arises, Are all the specific processes of metabolism reducible to physico-chemical terms?

[1] William Bateson, *Problems of Genetics*, 1913, pp. 38–39, 82; cf. 85–89. (Quotations are by courtesy of the Yale University Press, New Haven.)

[2] Driesch, *The Science and Philosophy of the Organism*, 1907, p. 141. (Quotations are by courtesy of Messrs. A. and C. Black, Ltd., London.)

[3] Wilson, *The Cell in Development and Inheritance*, 1919, p. 111.

[4] Jacques Loeb, *The Organism as a Whole*, 1919, pp. 28–29.

[5] Driesch, *The Science and Philosophy of the Organism*, 1907, pp. 93–94.

Food for all animals is in the form of proteins, carbohydrates, and fats. Water is of course also necessary. Although animals can digest these substances, they cannot form them; the source of animal food is found in plants. Plants have two kinds of assimilatory mechanism, which, though probably not wholly separate, may be so regarded provisionally for purposes of description. One of these is the agency for storing energy in the form of carbohydrates, the other is that for making proteins, which form the tissues of the plant. The first process is based on the power of the chlorophyll of the green leaves to absorb carbon dioxide (CO_2) from the air, and through the energy which it gets from sunlight to combine this carbon dioxide and water, by means of chemical processes not wholly known, into carbohydrates, often cane-sugar ($C_{12}H_{22}O_{11}$); these carbohydrates, when stored for future use, become starch. The total process is accompanied by the liberation of oxygen.

In the second process, proteins are formed in the leaves alongside the chlorophyll apparatus or in other cells. Water and nitrogen and other substances come from the soil through the roots, a process that is aided by the action of nitrogen-forming bacteria. How these substances are built into proteins is not known, but the process is apparently dependent on the activity of live protoplasm. The protoplasmic cells of the plant, by using the stored energy, are able to keep up their temperature, to grow, and to make the various reactions necessary to life. Plants thus contain an apparatus complete in itself. When using stored food, they exhibit the same metabolic processes as are found in animals; they consume oxygen and give forth carbon dioxide. "Thus the celluloses, sugars, starches, and other similar substances deposit their kinetic or stored energy in the tissues of the plant and release that energy through the addition of oxygen, the amount of oxygen required being the same as that needed to burn these substances in the air to

the same degree; in brief, through a combustion which generates heat." [1]

All this is not sufficient to give even an ideally conceived physico-chemical description of nutrition; for life is dependent on the activity of chlorophyll, and this is found only in connection with living matter. Where, then, could sugar come from, "which seems a prerequisite for the synthesis of proteins in living organisms"? [2] From the action of certain bacteria. "We may, therefore, consider it an established fact that there are a number of organisms which could have lived on this planet at a time when only mineral constituents, such as phosphates, K, Mg, So_4, Co_2, and O_2, besides NH_3, or SH_2, existed. This would lead us to consider it possible that the first organisms on this planet may have belonged to that world of micro-organisms which was discovered by Winogradsky.

"If we can conceive of this group of organisms as producing sugar, which in fact they do, they could have served as a basis for the development of other forms which require organic material for their development." [3]

This of course only pushes the problem farther back; but "it is at least not inconceivable that in an earlier period of the earth's history radio-activity, electrical discharges, and possibly also the action of volcanoes might have furnished the combination of circumstances under which living matter might have been formed. The staggering difficulties in imagining such a possibility are not merely on the chemical side — *e.g.*, the production of proteins from CO_2 and N — but also on the physical side if the necessity of a definite cell structure is considered." For "without a structure in the egg to begin with, no formation of a complicated organism is imaginable." [4]

[1] H. F. Osborn, *The Origin and Evolution of Life*, 1916, p. 52.
[2] Loeb, *The Organism as a Whole*, p. 16.
[3] *Ibid.*, p. 26.
[4] *Ibid.*, p. 39.

We have seen that conceivably living matter may be formed from the inorganic, but there is a difficulty that we have not yet solved. Life in the higher organisms goes on through the oxidization of proteins, carbohydrates, and fats. Now, this process occurs in the laboratory only very slowly except at a high temperature, that of flame. Berzelius solved this problem in the discovery of catalyzers, substances which facilitate chemical reactions but which are not used up in the process.[1]

Metabolism is thus a process which roughly preserves the cell and the organism in a state of equilibrium. We can, perhaps, conceive how this might be a physico-chemical process. According to Verworn, some further proof that it is such a process is furnished by the fact that metabolism is analogous to processes which we observe in the inorganic world:

"In my 'Biogen hypothesis,'[2] I have associated the self-regulation of metabolism with the chemical equilibrium in inter-reacting masses. I have considered the metabolic self-regulation as the expression of the formation of a mass equilibrium between the quantity of foodstuffs and the quantity of a hypothetical combination of living substance, the *biogen*, which continuously disintegrates and builds up again of its own accord. In fact, however, we have in the chemical equilibrium of reacting mixtures in the non-living world, a principle which is completely analogous to the self-regulation in living substance. The chemical facts are, indeed, well known. If we take the classical example of the formation of ethylacetate from acetic acid and alcohol, we have a case of an inanimate system, in which the amounts of the reacting substances are in constant equilibrium. The reaction following the mixture of equal amounts of alcohol and acetic acid is as follows:

[1] Loeb, *The Mechanistic Conception of Life*, 1912, pp. 4–5.

[2] Verworn refers to his *Die Biogenhypothese*, Jena, 1903; also to his *Allgemeine Physiologie*, 5th ed., Jena, 1909.

$$\tfrac{1}{3}\ \text{Mol.}\ C_2H_5OH + \tfrac{1}{3}\ \text{Mol.}\ CH_3COOH = \tfrac{2}{3}\ \text{Mol.}\ CH_3COOC_2H_5 + \tfrac{2}{3}\ \text{Mol.}\ H_2O.$$

"In this reaction there is an alteration only in the absolute quantity of the individual constituents but never in the relative amount. In the living system we have a completely analogous instance, which apart from its course differs from the inanimate example merely in the following points: In the first place, certain quantities of substances reacting on each other are continually introduced into and certain reaction products continually removed from the living system. Secondly, the reacting mixture of the living substance is not homogeneous, and at the same time is more complicated than that of the inanimate example. Thirdly, the sum total of the reaction is not reversible in its entirety. The question arises, should any essential difference between metabolic self-regulation and the maintenance of chemical equilibrium be assumed upon this statement? I must confess that this does not appear to me to be the case." [1]

An indication that metabolism is physico-chemical is furnished by certain experiments which apparently show that the organism obeys, in its metabolical processes, the law of the conservation of energy; that is, the in-go and the out-go are equal. Organisms take in food and use it up in external and internal activity. It has been found through calorimeter observations that, within the limits of experimental error, the amount of heat energy given out by an animal equals the amount of food taken in. The difference amounts to from 0.1% to 0.5%.[2]

Moreover, a detailed physico-chemical description of metabolism is at least conceivable. One of the difficulties in such an explanation is the fact that organisms select their nourishment. Rose-plants in the same soil produce flowers of different colors.

[1] Verworn, *Irritability*, 1913, pp. 112–113. (By courtesy of the Yale University Press.)

[2] J. A. Thomson, *The System of Animate Nature*, 1920, i, 112.

The cells of our body constituting the different glands, nerves, muscles, sense-organs, and skin are all bathed in the same nutritive fluid, but they select different materials from this fluid. Also the wandering leucocytes in the blood pursue and devour certain bacteria.[1] How can this fact of selection be explained in physico-chemical terms? Verworn answers that it is possible to explain it through the activity of semi-permeable membranes and the fact that different cells possess different biogen elements; so selection is merely a chemical selection. The surfaces of cells exhibit the characteristics of semi-permeable membranes and obey the laws of osmosis. Recent researches have shown that semi-permeable membranes select what they allow to pass, and that in cells the properties of the membranes may change under different conditions of cell-activity. Therefore "it is possible to formulate a general law for all living substance only to this extent; that the interchange of material between the cells and medium rests on the one hand on laws of diffusion which, owing to the specific properties of the semi-permeable surface of the cell, are influenced in a selective manner, and on the other hand by the chemical processes in the cell."[2] This explains choice, for every cell contains a specific substance and has its own chemical affinity, determined by its "biogen."[3]

The process of metabolism, then, uses the same material that we find in the organic world. Its process is similar to combustion. It obeys the law of conservation of energy. It is analogous to processes in the physical world, and a detailed physico-chemical explanation is conceivable. On the other hand, it is

[1] Cf., on the authority of Driesch (*Science and Philosophy of the Organism*, 1907, p. 206), Élie Metschnikoff's *Leçons sur la pathologie comparée de l'inflammation*, 1892 (Driesch says 1902, but I do not find such an edition).

[2] Verworn, *Allgemeine Physiologie*, 1915, p. 662. (By courtesy of Gustav Fischer, Jena.)

[3] For the biogen theory, especially as concerns metabolism, see *ibid.*, pp. 170–176, 661–678.

held by many that these metabolic processes are unlike anything that is found in the inorganic world. We have seen that even Loeb, a pronounced mechanist, holds that metabolism is a unique property of living substance. Let us now examine some of the differences between metabolism and inorganic processes, and some of the reasons given for holding that the process cannot be stated in mechanistic terms.

Casimir Funk and Benjamin Harrow call attention to the fact that, even if a sufficient number of calories are furnished, the organism will deteriorate unless what are called "vitamines" are present. "The calorie is a 'machine' unit, whereas man is more than a machine." [1]

According to Professor Hans Driesch, fungi will consume and thrive on very diverse and sometimes abnormal chemical compounds; if several kinds of these foods are furnished, fungi will consume them indifferently as to their chemical constitution but selectively as to their nutritive value. This is not at all what physico-chemical systems usually do, but it is not inconsistent with a possible activity of enzymes or ferments which could react to many compounds and exhibit a selective tendency. The most striking example, however, is furnished by the fact of "immunity," which may perhaps be described as a change in the total metabolic processes whereby poisons introduced into the system, which would ordinarily be absorbed and would eventually destroy the system, are neutralized. Thus, when animal and vegetable poisons—such as those produced by bacteria—are introduced into the organism, "anti-bodies" are produced in the fluids of the organism which neutralize the effect of the poison. Moreover, the organism achieves an acquired

[1] "Shall the Calories be Forgotten?" in *Harper's Magazine*, February, 1923, p. 360 (quoted by courtesy of Messrs. Harper and Brothers, New York and London). Cf. Sir C. S. Sherrington's "Some Aspects of Animal Mechanism" (British Association, *Report*, 1922, pp. 3–4), which admits these facts, but holds that they mean that there is more mechanism still to discover.

immunity that protects it from these poisons for some time to come. This process implies not only that enough "anti-body" is produced to neutralize the amount of poison present at the moment, but also that more is produced than is necessary. On this over-production of "anti-bodies" depends all immunity such as is caused by vaccinations and by injections of serums. "This phenomenon in particular — the production of *more* of the antitoxin or the 'percipitin' than is actually necessary — seems to render almost impossible any merely chemical theory of these facts." [1]

Moreover, although cells exhibit the properties of semi-permeable membranes, the ordinary physical characteristics of such membranes will not explain all the facts of metabolism; and many believe that no such physico-chemical explanation is possible. Some of the facts that make such an explanation difficult are these:

1. An animal's own serum can be absorbed.

2. Salt and other solutions of higher concentration than that of the blood can be absorbed. This absorption cannot be explained by ordinary physical laws. In all such cases the epithelial lining must be intact. When this is destroyed the intestinal wall acts like any other membrane and the purely physical laws of osmotic pressure come into play.[2]

3. Metabolism consists not only in the absorption of food and the elimination of waste products, but also in the absorption of oxygen.[3] Dr. Haldane, in an interesting study on the

[1] Driesch, *The Science and Philosophy of the Organism*, 1907, pp. 207–208.

[2] *Encyclopædia Britannica*, 11th ed., "Nutrition." Cf. R. S. Lillie, "The Transmission of Physiological Influence in Nerve and other Forms of Living Matter," in *Scientia*, xxviii (1920), 429–444; Lillie, "Growth in Living and Non-living Systems," in *Scientific Monthly*, xiv (1922), 113–130; E. Herzfeld and R. Klinger, "Chemische Studien zur Physiologie und Pathologie. V. Über 'lösliche und unlösliche' Kolloide; über echte und unechte Gallerten; das Protoplasma und das Problem der Zellpermeabilität," in *Biochemische Zeitschrift*, lxxxviii (1918), 232–282; Benjamin Moore, *Biochemistry*, 1921, p. 249.

[3] Driesch, *op. cit.*, p. 198.

"Physiology of Breathing," concludes that under certain conditions the layer of "moist albuminous material" which separates the air in the lungs from the blood accelerates the passage of oxygen, and of oxygen alone, into the blood and brings about a higher pressure in the blood than in the air, and that this process occurs only in living membranes. Many other living tissues act in a similar manner, as the swim-bladder of deep-sea fishes; the pressure of oxygen in the sea is about one fifth of an atmosphere, but in these bladders the pressure may be one hundred atmospheres.[1] The process can be understood only as a regulation involving the whole organism;[2] and, since the regulation concerns both the internal environment and the structure of the body, it is useless to attempt to explain one by the other. No physical explanation of these processes has been reached.[3] Dr. Haldane's final conclusion is that, even if mechanism is insufficient to explain physiological function, "vitalism" is also inconceivable, that some new way of re-interpreting physical concepts is the ultimate solution.[4] Meanwhile we must consider organisms as involving an order which is not mechanistic.[5]

B. Individual Development — Artificial Parthenogenesis

In the higher organisms, as we have seen, the normal condition of development of a new individual is the union of two germ-cells. Some of the lower organisms produce new individuals from eggs not fertilized by a spermatozoon. This process is parthenogenesis. "In a number of forms in which parthen-

[1] John Scott Haldane, *Organism and Environment as Illustrated by the Physiology of Breathing*, 1917, pp. 61–62. For more complete accounts, see his *Respiration*, 1922, and his *Mechanism, Life, and Personality*, 2d ed., 1921.
[2] *Organism and Environment*, etc., pp. 89–97.
[3] *Ibid.*, pp. 91–92.
[4] *Ibid.*, pp. 112–116.
[5] Cf. J. A. Thomson, *The System of Animate Nature*, i, 113–122.

ogenesis never occurs normally, so far as is known, it can be induced by appropriate extraneous procedures."[1] These have been especially studied by Jacques Loeb,[2] whose work should be read in the original. For our purposes a clear summary of certain significant experiments given by Dr. Pearl is sufficient. He accepts Loeb's interpretation of the results.[3]

Normal frogs have been produced by artificial parthenogenesis: unfertilized eggs of a virgin female were pricked with a needle. In one case the eggs began to develop March 16, 1916, and in another February 27, 1917. In the first case the date of death was May 22, 1917, and in the second March 24, 1918[4]

The unfertilized eggs of sea-urchins die comparatively soon when deposited in sea-water; after about thirty-two hours the egg cannot be fertilized By adding the proper amount of potassium cyanide Loeb found that many eggs could be fertilized and would develop into swimming larvæ[5]

Fertilized eggs of sea-urchins were put into flasks which contained 100 c. c. of sea-water, to which 16 c c. 2½ m. $CaCl_2$ had been added. In a certain flask the oxygen was expelled. When after a period of some hours the eggs were transferred to aerated normal sea-water, those which had been in the solution without oxygen for four hours and fourteen minutes segmented and in most cases developed larvæ; of those which were in the solution five and a half hours 90% segmented. The eggs that were in the flask supplied with oxygen were dead.[6]

If the unfertilized eggs of the sea-urchin are subjected to the following treatment they will develop The eggs are first placed in sea-water to which a definite amount of weak solution of butyric acid has been added, and are left from one and a half to

[1] Raymond Pearl, *The Biology of Death*, 1922, p 51
[2] Loeb, *The Organism as a Whole*, 1916
[3] Pearl, *The Biology of Death*, p 57.
[4] *Ibid*, p 52, Loeb, *The Organism as a Whole*, pp 124–125
[5] Pearl, *The Biology of Death*, pp 52–54 [6] *Ibid*, p 55

three or four minutes. They are then put into normal sea-water for fifteen or twenty minutes, and are then removed to another tank of sea-water for thirty to sixty minutes. The osmotic pressure of the water in this last receptacle has been raised by adding to every 50 c. c. of sea-water 8 c. c. of 2½ m NaCl, or 2½ m $NaCl + KCL + CaCl_2$, in the proportion in which these salts exist in sea-water. Eggs that are left in this solution just the right length of time develop into normal larvæ.[1] "In other words, we have here a definite and known physico-chemical process completely replacing what was, before this work, universally regarded as a peculiarly vital process of extraordinary complexity, probably beyond power of human control."[2] Of course these experiments prove only that a *live* germ-cell may be stimulated to normal development by physical stimuli. This does not prove by itself that life is physico-chemical, but without doubt it furnishes some evidence in support of such a view.

The facts of regeneration are very interesting in connection with this discussion of the various theories of the nature of life. Regeneration is the power of reproducing anew destroyed or injured parts, and is a retained power of developing over again. It is not found to an equal extent in all organisms, but some power of regeneration is common to all; for even the healing of a wound is, I suppose, a process of regeneration. Regeneration, therefore, depends on the fact that organisms have the power of unlimited reproduction and of preserving their own specific form. Now, the "structure of any animal or plant is the product of the balance between its own constitution and the environment that surrounds it."[3] But this is also a property of some inorganic matter. Thus a drop of mercury in a saucer takes the shape of a sphere; if it is divided, each half takes a spherical

[1] Pearl, *The Biology of Death*, pp. 56–57.
[2] *Ibid.*, p. 57.
[3] Julian S. Huxley, "Biology," in *The Outline of Science*, ed. J. A. Thomson, 1922, iii, 689.

form. "If a drop of mercury were an organism, we should say that its typical form was spherical, and that any fragment of the whole was capable of reorganising itself in the typical form."[1] Organisms do likewise. For example, the fertilized eggs of newts have been separated after the first division into two cells; in this case twin newts were produced. This separation and development have been brought about in the case of eggs of a number of species. "Perhaps the most striking of these cases is that of the hydroid *Clytia,* in which Zoja was able to obtain perfect embryos, not only from the blastomeres of the two-cell and four-cell stages, but from eight-cell and even from sixteen-cell stages, the dwarfs in the last case being but one-sixteenth the normal size."[2]

Driesch subjected frogs' eggs to pressure so that the form of early segmentation was much changed; but embryos were formed, nevertheless, without rearrangement of the parts.[3] Morgan has shown that either a half-embryo or a whole dwarf may result according to the position of the blastomere.

Loeb showed that *Tubularia,* like many other hydroids, could grow a new head, but that environment influenced the process. If a *Tubularia* stem is cut off at both ends and the oral end is inserted in sand, a new head will grow on the former aboral end. If it is suspended in water, a new head will form at each end. If both ends are buried in sand, no regeneration results.[4]

Under various conditions a piece of flatworm will produce a head in the head region, and this new head seems to control the rest so that new parts are formed in order from head to tail. Below a certain temperature the flatworm will not grow a head and at a high temperature it will grow a very large head. Here the outward environment seems to control the conditions of growth.

[1] Huxley, "Biology," p. 689.
[2] E. B. Wilson, *The Cell in Development and Inheritance,* p. 410.
[3] *Ibid.,* pp. 410–411. [4] *Ibid.,* p. 430.

A good example of the influence of one part over another, of the influence of what may be called internal environment, is given in the regeneration of the eyes of newts and salamanders. "The sensitive part or retina is derived from a cup-like outgrowth arising from the brain — the optic cup; the lens is formed as a thickening in the skin just over the cup. Various experiments have proved that the formation of the lens at the exact place in which it will be useful is due to some chemical influence (of the same nature, no doubt, as that exerted by the ductless glands . . .) exerted upon the skin by the developing optic cup. If the skin is removed from the side of the head over the cup, and a piece from some other part of the body, or even from some other animal, is grafted on in its place, the new grafted piece will produce a lens. But if the optic cup is taken out and grafted under the skin elsewhere, for example, near the tail, no lens will be formed in the bead, but one will be produced over the optic cup in the tail region."[1] It is largely by such influence of one part upon another that the progressive increase of complexity in development comes about, a conclusion with which many authorities agree.[2]

But although environment, including position and the influence of one part on another, no doubt describes the process of development and regeneration to a certain extent, as yet no explanation is offered. Let us see what Loeb has to say on this whole subject.

"The action of the organism as a whole seems nowhere more pronounced than in the phenomena of regeneration, for it is the organism as a whole which represses the phenomena of regeneration in its parts, and it is the isolation of the part from the influence of the whole which sets in action the process of regeneration. . . . When a piece is cut from the branch of a

[1] Huxley, "Biology," pp. 692–693.
[2] Wilson, *The Cell*, etc., pp. 415–416.

willow it forms roots near the lower end and shoots at the upper end, so that a tolerably presentable 'whole' is restored. How does the 'whole' prevent the basal end of the shoot from forming roots as long as it is part of the plant?"[1]

The explanation is to be found in the action of specific substances that cause the formation of shoots and roots. In the normal plant these substances flow to the top and the bottom of the plant and there produce their characteristic results. When a piece is cut from the plant these substances behave as before; shoots are formed at the top, roots at the basal end.

That such substances — internal secretions or hormones — are produced in animals also is shown by numerous facts:

1. Gudernatsch observed that he could make legs grow in tadpoles at any time by feeding them with thyroid glands taken from no matter what animal.[2]

2. Degeneration of the thyroid often stops growth in a child, but if the patient is fed with thyroid growth will start again.[3]

3. In the metamorphosis of the *Amblystoma* larva the gills at the head and tail change and are absorbed simultaneously. If the spinal cord is cut in two, the changes occur as usual.[4]

These facts show that "substances circulating in the blood and not the central nervous system are responsible for the phenomena of growth and metamorphosis."[4]

4. In periods of growth and moulting in the higher crustacea there is a heaping-up of glycogen in the liver. Between moultings, when there is no growth, the storage cells are filled with fat globules.[5]

These "organ-forming" substances will explain regeneration. The resting egg may be caused to develop either by substanees

[1] Loeb, *The Organism as a Whole*, p. 153.
[2] *Ibid.*, pp. 155–156.
[3] *Ibid.*, p. 156
[4] *Ibid.*, p. 157.
[5] *Ibid.*, p. 159.

contained in the sperm or by other substances. Assume, then, that an organism has cells comparable to those of the resting egg, which may be aroused to action by substances circulating in the organism. In the normal organism these substances are confined to definite regions and in these regions they induce their characteristic results. In regeneration they activate the dormant cells.[1] Thus the influence of environment on the regeneration of *Tubularia* is due to changes in the flow of some activating substance.[2] Loeb's conclusion is that, while our knowledge of regeneration is incomplete, "it seems that the known facts warrant the statement that the phenomena of regeneration belong as much to the domain of determinism as those of any of the partial phenomena of physiology."[3]

But, giving full credit to similar facts, Mr. E. B. Wilson says that in all cases of development the response is due not to the environmental condition but to the nature of the organism; the egg of a fish and that of a polyp develop under the same conditions into different organisms. What the nature of this power of the organism is we do not know;[4] and Dr. Driesch, considering the facts that parts of the germ may produce a whole and that lost parts may be reproduced or regenerated, concludes that no conceivable machine could do this.

Driesch describes organisms as harmonious-equipotential systems. After a careful consideration of experiments similar to those we have mentioned, he concludes:

"It seems to me that there is only one conclusion possible. If we are going to explain what happens in our harmonious-equipotential systems by the aid of causality based upon the constellation of single physical or chemical factors and events, there *must* be some such thing as a machine. Now the assump-

[1] Loeb, *The Organism as a Whole*, pp. 160–161.
[2] *Ibid.*, pp. 168–169. [3] *Ibid.*, p. 197.
[4] Cf. Wilson, *The Cell*, etc., pp. 433–434.

tion of the existence of a machine proves to be absolutely absurd in the light of the experimental facts. *Therefore there can be neither any sort of a machine nor any sort of causality based upon constellation underlying the differentiation of harmonious-equipotential systems.*

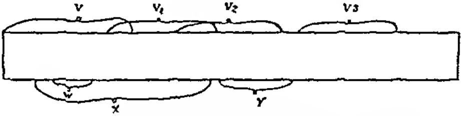


FIG. 14.—AN 'HARMONIOUS-EQUIPOTENTIAL SYSTEM' OF WHATEVER KIND

According to the 'machine-theory' of life this system ought to possess a certain unknown very complicated machine *in its completeness:*

(*a*) in its total length,
and (*b*) in each of the equal volumes v, v_1, v_2, v_3, and so on,
and (*c*) in each of the unequal volumes w, x, y, and so on,
and (*d*) in every imaginable volume, no matter of what size.

Therefore the 'machine-theory' of life is absurd.

"For a machine, typical with regard to the three chief dimensions of space, cannot remain itself if you remove parts of it or if you rearrange its parts at will.

"Here we see that our long and careful study of morphogenesis has been worth while: it has afforded us a result of the very first importance.

"*The Autonomy of Morphogenesis Proved*

"No kind of causality based upon the constellations of single physical and chemical acts can account for organic individual development; this development is not to be explained by any hypothesis about configuration of physical and chemical agents. Therefore there must be something else which is to be regarded as the sufficient reason of individual form-production. . . . Life, at least morphogenesis, is not a specialised arrangement of

inorganic events; biology, therefore, is not applied physics and chemistry: life is something apart, and biology is an independent science. . . .

"We shall not hesitate to call by its proper name what we believe we have proved about morphogenetic phenomena." It is "the doctrine of the *autonomy of life*" and the name of the autonomous factor is "*Entelechy*."[1]

And Mr. J. Arthur Thomson, commenting on this discussion, says: "It is not unfair to recall some of the difficulties, — that the supposed mechanism has to form in fertilisation a working unity with another mechanism as complex as itself; that it has thereafter to divide over and over again; that a part is sometimes as good as a whole; and so on. . . . It almost seems as if we here reached a Euclidean *reductio ad absurdum* of a mechanistic interpretation."[2]

[1] Driesch, *The Science and Philosophy of the Organism*, 1907, pp. 141–144 (by courtesy of Messrs. A. and C. Black, Ltd., London). For the whole discussion, see pp. 1–146.

[2] Thomson, *The System of Animate Nature*, i, 128. (Quotations are by courtesy of Messrs. Williams and Norgate, London, and of Henry Holt and Company, New York.)

CHAPTER XVI

FUNCTIONS OF ORGANISMS

C. Movement and Irritability

A similar conflict of opinion is noticeable in the explanations of organic behavior. The capability of the organism of responding to alteration in the external vital conditions by changes in the vital processes may be given the very general name of irritability.[1] In so far as irritability is mere response to environment, it is a universal property of living substance, but it is not necessarily confined to living substance.[2] Dr. Jagadis Chunder Bose has studied the response of a great variety of objects measured by the deflection of the needle of a galvanometer; he has experimented on metals, plants, and organic tissues, including nerves. He thinks he has been able to show that all forms, both organic and inorganic, obey the same laws, — are subject to fatigue, show an ascending response to repeated stimuli, are affected by poisons, — and that these effects persist in the inorganic. For instance, a bit of tin wire stimulated by oxalic acid, then washed and scrubbed with emery paper, still failed to show the characteristic response which a normal bit of tin wire displayed.[3] "Thus living response in all its diverse manifestations is found to be only a repetition of responses seen in the inorganic. There is in it no element of mystery or caprice, such as we must admit to be applied in the assumption of a hyper-mechanical vital force, acting in contradiction or defiance of

[1] Max Verworn, *Irritability*, p. 39.

[2] *Ibid.*, p. 1.

[3] Bose, *Comparative Electro-Physiology*, 1907, pp. 9, 682–683; *Response in the Living and Non-Living*, 1902, pp. 140–147.

those physical laws that govern the world of matter. Nowhere in the entire range of these response-phenomena — inclusive as that is of metals, plants, and animals — do we detect any breach of continuity."[1]

"In this demonstration of continuity, then, it has been found that the dividing frontiers between Physics, Physiology, and Psychology have disappeared."[2]

Verworn, while not holding that the problem is solved, believes that a beginning has been made and that organic irritability, both excitation and depression, can be referred to changes in metabolism connected with that of oxygen and can be expressed in physico-chemical terms. Since response takes the form of movement, Verworn goes to great lengths to show that contraction of the muscles and amœboid movement are due to physico-chemical causes. These movements in the lower organisms take the form of what are called tropisms. Let us examine some of these mechanistic attempts to account for movements.

One of the most interesting studies is that of Dr. Asa A. Schaeffer, who concludes, after the examination of an immense amount of evidence, that amœboid movement is connected with "the surface energy in the interfaces in the colloidal system,"[3] and that the control of the streaming process will be in part solved when the mechanics of streaming are understood. But, although a complete mechanical account is not yet given, yet experiments show that a large number of representative organisms — amœbæ, worms, the larvæ of many species, man, and perhaps horses and dogs — if moving spontaneously, not under the influence of any specific stimulus, move in orderly,

[1] Bose, *Response in the Living and Non-Living*, pp. 189–199.

[2] Bose, *Comparative Electro-Physiology*, p. 733. (These two quotations are by courtesy of Messrs. Longmans, Green, and Company, New York.)

[3] Schaeffer, *Ameboid Movement*, 1920, p. 104. (By courtesy of the Princeton University Press, Princeton, N. J.)

spiral paths. "This mechanism, being automatic, absolutely controls the direction of the path so long as outside interferences permit; but when sensory stimulation occurs, or when changes in temperature, etc., occur, the mechanism is no longer able to operate automatically or smoothly. The direction of the path then depends upon the nature and direction from which stimulation was received, and upon the degree and direction of change of temperature, etc.

"The importance of this conception of movement lies in the fact that it enables us to look at a large mass of otherwise unrelated data from a single point of view. Secondly, it permits of a mathematical treatment of the whole subject of movement in organisms. And third, it replaces a teleological explanation of spiral movement in unicellulars, swarm spores, rotifers, etc., with a purely mechanistic explanation." [1]

The study of movement in organisms has shown that they exhibit certain ways of reacting under observed conditions which are often as fixed and unchangeable as the reactions of chemical substances. These reactions, tropisms, are very diverse. Thus the stem of a plant grows toward the light, positive heliotropism; the roots toward the earth, geotropism. "Certain organisms have a tendency to bring their bodies as much as possible on all sides in contact with solid bodies; thus the butterfly *Amphipyra*, which is a fast runner, will come to rest under a glass plate when the plate is put high enough above the ground so that it touches the back of the butterfly. The animals which live under stones or underground or in caves are as a rule both negatively heliotropic and positively stereotropic. Their tropisms predestine or force them into the life they lead." [2]

Many organisms change their direction in response to chemical stimuli, chemotropism. Thus Pfeffer found that the sperm-

[1] Schaeffer, *op. cit.*, p. 141.
[2] Jacques Loeb, *The Organism as a Whole*, 1916, p 283

atozoa of ferns, when moving in a straight line in water, will deviate if near an archegonium; they will turn and enter the egg. Moreover, 0.01% of malic acid in a capillary tube will attract these spermatozoa.[1]

In some organisms heliotropism is very interesting. Loeb found that plant-lice from rose-bushes, if put in a test-tube, move to the end of the tube nearest the source of light. If the tube is turned through 180°, the lice leave their position and again move toward the source of the illumination. A still more interesting example is given by the caterpillar of *Porthesia chrysorrhœa*. The eggs of this species are deposited on the stems of shrubs; the larvæ, when hatched, crawl up the stems toward the light and find food on the leaves at the extremities of the branches. These larvæ, when hungry, if put into a tube with their favorite food at the end removed from the source of light, always go toward the light. After feeding at the top end of the branches the larvæ turn and go down, thus finding more food. If larvæ which have fed be put into tubes under similar conditions, they exhibit no heliotropism. Loeb's explanation of such facts is that heliotropic organisms have a specific chemical constitution of such a nature that light, by a photo-chemical process which increases oxidation, makes them seek the source of light. Since these organisms are symmetrical, light that strikes one side will increase the chemical activity on that side and make them turn toward the source. This chemical constitution of organisms can be changed by chemical agencies and by food. Thus, when hungry, the larvæ of *Chrysorrhœa* turn toward light and move toward it, but after they have fed chemical changes occur and they no longer do this. Heliotropic animals are thus photometric machines. An extension of this kind of explanation is regarded as sufficient to explain all instinctive movement; and, I suppose, a further extension of the theory, by postulating

[1] Loeb, *The Organism as a Whole*, p. 92.

a complex combination of instincts, would be held to explain all behavior.[1]

The following observations are believed to show that instincts are like tropisms. A male butterfly will deviate from its flight and light on a wooden box in which is a female of its own species.[2] The arms of a male frog in the spawning season develop a powerful positive stereotropism, so that the frog will grasp a piece of wood or other object as well as the female. "The act of seeking the female as well as that of cohabitation are in many cases combinations of chemotropism and stereotropism. The development of these tropisms depends upon the presence of certain specific substances in the body, a fact emphasized already in the case of heliotropism. In case of the development of the segmental stereotropism of the male frog at the time of spawning it has been shown that it depends on an internal secretion from the testes." [3]

Even in the higher animals the experiments of Cannon [4] have shown that chemical substances, such as adrenalin, have great importance in the reactions connected with the expression of fear; emotions in man, then, "may be determined by specific substances which also determine the tropistic reaction." [5] So that, "aside from heliotropism, chemotropism as well as stereotropism play the most essential rôle in the so-called instinctive actions of animals." [6]

The experiments of Steinach show what an extraordinary influence the secretions of some glands have on instinctive behavior, and suggest the possibility of a physico-chemical explanation of instinct.[7]

[1] Loeb, *The Mechanistic Conception of Life*, 1912, ch. ii, "The Significance of Tropisms for Psychology"; *The Organism as a Whole*, ch. x, "Animal Instincts and Tropisms."

[2] Loeb, *The Organism as a Whole*, p. 283.

[3] *Ibid.*, p. 284.

[4] Walter B. Cannon, *Bodily Changes in Pain, Hunger, Fear, and Rage*, 1915.

[5] Loeb, *The Organism as a Whole*, pp. 284–285.

[6] *Ibid.*, p. 283.

[7] *Ibid.*, p. 285.

"Bouin and Ancel had already suggested that the sexual glands of mammals have two independent constituents, the sexual cells and the interstitial tissue; and that the latter tissue is responsible for the development of the secondary sexual character. This has been proved definitely by Steinach,[1] who showed that when young rats are castrated certain secondary sexual characters are not fully developed. The seminal vesicles and the prostate remain rudimentary and the penis develops incompletely. Such animals when adult recognize the female and seem to follow it, but do not persist in their attention and neither erection nor cohabitation occurs. When, however, the testes are retransplanted into the muscles of the castrated young animal (so that they are no longer connected with their nerves) seminal vesicles, prostate, and penis develop normally, and these animals show normal sexual ardour and cohabitate with a female although the female cannot become pregnant since the males cannot ejaculate any sperm. When the retransplanted testes were examined it was found that all the sperm cells had perished, only the interstitial tissue of the testes remaining. It was, therefore, proved that the development of the seminal vesicles, the prostate, the penis, and the normal sexual instincts and activities depends upon the internal secretions from this interstitial tissue and not upon the sex cells proper. This agrees with the conclusions at which Bouin and Ancel had arrived by ligaturing the vasa deferentia of male animals.

"Steinach in another series of experiments castrated young male rats and transplanted into them the ovaries of young females. These ovaries did not disintegrate, the eggs remaining, and corpora lutea were formed. In such feminized individuals the seminal vesicles, prostate, and penis did not reach their normal development, and it was thereby proved that the inter-

[1] Loeb refers here to "Steinach, E., *Zentralbl. f. Physiol.*, 1910, xxiv., 551; *Arch. f. d. ges. Physiol.*, 1912, cxliv., 72."

nal secretions from the ovary do not promote the growth of the secondary sexual male characters. On the contrary, Steinach was able to show that the growth of the penis was directly inhibited by the ovary, since in the feminized males this organ remained smaller than in the merely castrated animals. On the other hand the infantile uterus and tube when transplanted into the young male with the ovaries grow in a normal way, and Steinach thinks that pregnancy in such feminized males is possible if sperm be injected into the uterus. In some regards the feminized males showed the morphological habitus of females. Soon after the transplantation of ovaries into a castrated male the nipples of its mammary glands begin to grow to the large size which they have in the female and by which the two sexes can easily be discriminated. In addition the stronger longitudinal growth of the body in the male does not occur in the feminized specimens, the body growth becomes that of a female; and likewise the fat and hair of the feminized male resemble that of a real female.

"While the castrated males show an interest in the females, the feminized males are absolutely indifferent to females and behave like them when put together with normal males; and, what is more interesting, they are treated by normal males like normal females. The sexual instincts have, therefore, also been reversed in the feminized males by the substitution of ovaries for testes.

"The inhibition of the growth of the penis by the ovary is of importance; it supports the idea already expressed that in hermaphrodites this inhibition of the growth of the secondary organs of the other sex is only feeble or does not exist at all.

"We may finally ask whether there is any connection between the cytological basis of sex determination by special sex chromosomes and the physiological basis of sex determination by specific substances or internal secretions. It is possible that the

sex chromosomes determine or favour, in a way as yet unknown, the formation of the specific internal secretion discussed in the second part of this chapter. In this way all the facts of sex determination might be harmonized, and it may become clear that when it is possible to modify secretions by outside conditions or to feed the body with certain as yet unknown specific substances the influence of the sex chromosomes upon the determination of sex may be overcome." [1]

The interest of these experiments from our present point of view consists, of course, in the fact that instincts and emotions are apparently changed by chemical substances, by hormones secreted by the tissues of certain glands. While not proving that emotion and instinct are wholly physico-chemical, they would tend to show the enormous influence of such substances in determining conduct and giving at least form to the emotions.[2]

Another mode of behavior exhibited by instincts in some animals is of great interest, — the homing instinct. Thus bees fly to considerable distances in search of food and, when laden, find their way back to the hive. Carrier-pigeons show a like ability, and many similar stories are told of dogs and cats and other animals. According to Bethe, bees fly from the hive because when unladen they are negatively tropic to it, and they return to the hive when laden because they then become positively tropic to it. Some kind of force which is quite unknown to us compels them to return to the position in space from which they set out. This force may be a sort of radiant energy. We cannot suppose that bees know their way by vision, as a man would; for even if the hive is hidden they return with little trouble, and if it is moved they return to the spot where it was. Nor does it seem possible that they are guided by the sense of

[1] Loeb, *The Organism as a Whole*, pp. 225–228. (By courtesy of G. P. Putnam's Sons, New York and London.)

[2] Louis Berman (*The Glands regulating Personality*, 1921) turns this truth into an absurdity.

smell. Such is a condensation of the summary of Bethe's theory given by Dr. McDougall.[1] Of course an explanation like this seems strained and unreal. To Dr. McDougall's criticism we shall refer later.

The theory we have been surveying apparently holds that all organic movements *may ultimately* be reduced to tropisms, but there are other aspects of organic response which make some mechanists describe the process in other ways. "If the reader, comfortably seated, will cross his right knee over the other and sharply tap the tendon below the right knee-cap, his right foot will jerk forward owing to the contraction of the large muscles of the front of the thigh. That is a very simple reflex action."[2] That such reflex actions account for many facts of animal movements there is no doubt; thus walking is the combination of reflexes into a chain-reflex, the result of one reflex serving as the stimulus for another. Moreover, in some cases the reflex *may* be brought about by a different stimulus from the ordinary one. Such a "conditioned-reflex" was studied by Pavlov. A dog, if a savory morsel is shown to him, will secrete saliva. This is a pure reflex. If a bell is sounded many times when the food is shown, and finally if it is sounded without the sight of food, the dog will again secrete saliva. Now let us take the classical case of an ass that is equally hungry and thirsty and is placed precisely halfway between some hay and a pool of water. Will he starve and suffer thirst until he dies? Here we have two tendencies to reflexes, or to instinctive action, which inhibit each other; delayed action would result; if the animal were conscious, he would be deliberating.

Now, if we want a complete mechanistic theory of move-

[1] William McDougall, *Outline of Psychology*, 1923, pp. 81–82. Cf A Bethe, "Dürfen wir den Ameisen u. Bienen psychische Qualitäten zuschreiben," in *Archiv für die Gesammte Physiologie*, vol. lxx (1898).

[2] McDougall, *Outline*, p. 51. (Quotations are by courtesy of Charles Scribner's Sons, New York.)

ments, we might say with Loeb, as I understand him, that tropism is the typical elementary form; a typical reflex is a tropism which by long selection has become a specific reaction to a given kind of stimulus, and a combination of these segmental reactions, reflexes, and tropisms is instinctive behavior; a combination of chain, of conditioned, and of delayed reflexes and tropisms is all animal behavior; tropism is, however, the essential element from which the other aspects evolve. Others would say, with Verworn, that the typical elementary form of response is not a tropism, as ordinarily understood, not reflex, but diffuse, random movement, which has physico-chemical causes and which results from either a change in the internal conditions of the organism or from a change in the external conditions; these random movements, again, by a long process of selection become tropisms, reflexes, chain-reflexes, conditioned and delayed reflexes, all organic response; consciousness, if present at all, is a mere spectator.

That any such mechanistic explanation is inadequate is held by a host of biologists and psychologists; for example, by Dr. H. S. Jennings, Dr. Hans Driesch, Professor C. Lloyd Morgan, Mr. L. T. Hobhouse, Mr. J. Arthur Thomson, and Dr. William McDougall.[1] Their reasons for disputing the mechanical interpretation rest on the belief that organisms behave differently from the inorganic, that they exhibit purposive behavior. All these authors hold that a more or less definite objective criterion may be formulated that gives a rule for determining what is purposive behavior as opposed to what is mechanical sequence of movements. Dr. McDougall has best done this:

[1] Jennings, *Contributions to the Study of the Behavior of Lower Organisms*, 1904; Driesch, *The Science and Philosophy of the Organism*, 2 vols., 1907–1908; Morgan, *Instinct and Experience*, 1912; Hobhouse, *Development and Purpose*, 1913, and *Mind in Evolution*, 1915; Thomson, *The System of Animate Nature*, 1920; McDougall, *Body and Mind*, 5th ed., 1920, and *Outline of Psychology*, 1923.

1. Reflexes lack spontaneity, but purposive action displays it.
2. Reflexes lack persistency, since they cease when the stimulus ceases; but purposive action continues under these circumstances
3. The reflex is fixed, the same reaction occurs on the repetition of the same stimulus; but purposive action shows variations in response to the same stimulus.
4. Reflexes do not apparently exhibit the phenomenon of seeking a goal, but this is the very essence of purposive action.
5. Reflexes do not anticipate the coming situation; but, again, purpose is always preparation for something that is to follow.
6. Reflexes are not improved by repetition; but purposive action, if often repeated, is more easily performed.
7. Reflexes are always the reaction of a part of the organism, but purposive action is the action of the whole organism.[1]

The criterion of animal behavior, then, is purposive action, which is made up of these seven elements. For the moment let us not discuss this criterion, but let us see how it is applied.

To Dr. Herbert S. Jennings is due much of the modern work on the behavior of lower organisms which was foreshadowed by that of many naturalists and by M. Alfred Binet's *Psychic Life of Micro-organisms* (1889). The observations of Dr. Jennings are held to support the theory that even in the very lowest forms of life a certain kind of conscious, purposive activity must be postulated. I have taken the account of his experiments from Dr. McDougall, not because Dr. Jennings's own work does not deserve to be read by all who are interested, — on the contrary, it is fascinating and instructive, — but because Dr. McDougall gives an excellent summary and because the quotations will

[1] McDougall, *Outline of Psychology*, pp 53-56

show that the general results have his additional weighty support.

"Of such animals (*Protozoa*) the humblest and simplest is the *Amœba*. Yet here is a condensed chapter from the lives of two such creatures.[1] These unicellular specks of protoplasm creep over solid surfaces submerged in fresh water. A larger specimen, C, comes in contact with a smaller one, B. C thereupon changes the direction of its locomotion and sends out two long protuberances which begin to enclose B, as B continues on its path. This process continues until C completely encloses B, together with a quantity of water. C then stops and changes its direction, carrying B within it in a quiescent condition. After a brief period, the quiescent B bestirs itself and begins to emerge from C, sending protuberances out through a small canal left open in the substance of the enclosing C. Thereupon C reverses its movement and again completely encloses B, and again moves off in the opposite direction, carrying B within. Again B, by a few rapid movements, escapes from the 'posterior end' of its captor C, and becomes completely free and separated from C by a clear interval. Again C reverses, overtakes B, again engulfs it, and starts away in a new direction. B then seems resigned to its fate; it remains contracted to a spherical mass within C for some five minutes. But, after that time, B again bestirs itself, forces its way through the containing wall of C's substance, and finally escapes.

"It is clear that this series of movements resembles behavior, a series of purposive actions, far more closely than a series of tropisms. At any rate, the tropic theory is very far from having an adequate explanation to offer. . . .

"Even more suggestive of behavior or purposive action are the following reactions of Stentor, a slender vaselike creature. It consists of a single cell, but has a more differentiated structure

[1] McDougall refers to page 17 of Jennings's *Behavior of Lower Organisms*.

than most other *Protozoa*. The apex of its conical body is commonly attached to some solid surface; the base of the cone is surrounded with cilia, whose movements drive a current of water into a soft-walled depression, which is the mouth. This creature was bombarded with a stream of innutritious particles by Jennings, who describes the following series of reactions: (1) Stentor sweeps the particles into its 'mouth' for a short time; (2) it bends to one side, repeating this movement several times at short intervals; (3) it reverses the action of the cilia about its 'mouth,' so that the particles, instead of being ingested, are driven away; (4) after repeating this reversal two or three times, it contracts its whole body toward its base of attachment; (5) if, after several repetitions of this withdrawal, Stentor still encounters the stream of particles on extending itself, *it makes a more violent contraction of its whole body*, which results in its detachment from its fixed base; it then swims away and takes up a new position, again attaching itself to some solid surface. This sequence of reactions to the unvarying stimulus seems to exhibit in a rudimentary way all the marks of behavior. . . .

"We might with advantage dwell upon hundreds of examples of behavior among very simple animals. But I will cite only one more from the quite lowly region of the scale of life, a well-known bit of behavior of the common earthworm. It has long been common knowledge that an earthworm, when about to draw a leaf into its burrow, will seize it by the narrower end. Experiment on this cue with pieces of paper of various shapes has shown that an earthworm, whose sense-organs and nervous system are very simple, will explore the piece of paper which it is about to draw into its burrow, and will generally seize it by the most suitable corner for its purpose. Thus, if the paper be a triangle, having one angle distinctly more acute than the other two, it will seize the paper at the apex of this angle, which

obviously is the one that any intelligent being would choose, if its purpose was to drag the paper into a narrow round burrow.

"I confess that this behavior is staggering. It certainly cannot be explained as either a tropism or a conditioned reflex. In some sense the animal appreciates by successive touches the shape of the paper, or at least the nature of its angles; and in some sense it compares these, and chooses the one most suitable to its purpose. The behavior seems to imply and express a comparative judgment, as clearly as when I choose a shoe to fit my foot. We shall see that other animals a little higher in the scale behave in a variety of ways which seem to imply such judgment."[1]

Let us now return to the homing instinct to which we have referred, and to Bethe's mechanistic explanation of it. Dr. McDougall holds that such an instinct cannot be explained in mechanical terms. It has been observed that wasps, when first leaving their nests, spend some days or weeks in walking and flying about in a limited area; when they find food they immediately return to the nests. By degrees they go farther and farther away in search of food. It is by a gradual process, then, that the wasps are enabled to find their way back from long distances. This looks as if we were compelled to believe that "in some sense the wasp constructs and *carries with her a map or plan of the locality*."[2] In the case of bees, if the hive is moved the bees return to it with difficulty; and they do not return to the hive after dark.

"5. But far more conclusive is the following observation: Bees dwelling in hives which adjoined an arid district naturally foraged much in the fertile region on one side of the hives, and little or not at all in the arid region on the other side. It was found that, while bees carried to any point within the two-mile limit in the fertile zone did not fail to return, of those carried to

[1] McDougall, *Outline*, pp. 61–69. [2] *Ibid.*, p. 80.

similar distances in the unexplored arid zone many failed to return. . . .

"6. In New England, wild-bee hunting is a sport ardently pursued by some experts, whose method of locating the hives is very instructive in the present connection. The hunter captures a bee, and, having marked her with a spot of paint, puts her into a small box; where she feeds on syrup. When the bee has taken her fill she is released and, having (like the wasps) flown round a little, disappears in the distance; and the hunter sits down beside the box confidently awaiting her return. He is seldom disappointed. Under favorable conditions the bee usually returns (identified by her paint-spot) accompanied by others; and these also fill themselves with syrup and depart to the hive, to return again and again until the syrup is all harvested. . . . Here, then, is a new difficulty for the tropic theory. It must assume that yet another form of unknown energy radiates from the syrup, and that toward this the bees are positively tropic when they are unladen. . . .

"8. The experiments of Lubbock and others on bees (some of which I have repeated on social wasps with similar results) show clearly that bees are guided by vision; for, when the appearance of the objects about the hive is altered in form or color, the return of the bees to the hive is no longer so unerring as it normally is.

"9. The difficulties of applying the tropic theory to the case of the solitary wasps returning to their nests must, one might suppose, make even the most determined behaviorist pause a moment to think. The theory would have to assume (1) that each wasp deposits in the nest she makes a source of radiant energy peculiar to herself (for hundreds of wasps sometimes have their nests within a small space over which they all wander freely); (2) that the wasp is negatively tropic to this form of energy so long as she has no prey; (3) that the possession of the

prey reverses the sign of her tropism; (4) which is again reversed as soon as the prey is deposited with the egg in the nest. Truly, the behavior of the behaviorists lends some color to their theory; for it might well be maintained that the 'tropic' theory of the 'homing' of insects is the product, not of thought, but of the play of language mechanisms only." [1]

The natural explanation, according to Dr. McDougall, is that there is a tendency to return to the hive and that intelligence makes possible the fulfilment of this impulse. Instinct and intelligence go hand in hand: "*Intelligence here serves Instinct, and its service is essential; without it Instinct would be of no avail.*" [2]

Dr. McDougall clinches his argument by some additional examples:

"Let us glance now very rapidly at some other actions of the wasps. Of all the solitary wasps *Ammophila* has been raised to the highest pinnacle of fame, owing to Fabre's fascinating description of her behavior and Professor Bergson's alluring interpretation of it.

"Fabre has described how this wasp, which preys upon caterpillars, seizes her prey and, with marvellous precision, plunges her sting into the principal nerve ganglia, and thus paralyzes without killing her victim; how she then drags it to her nest and deposits her egg upon it, leaving it as a supply of fresh (because living) meat for the grub which will hatch from the egg. It is implied by both these eminent authors that, if the caterpillar were killed instead of being merely paralyzed, it would be useless to the grub, and that the whole cycle of instinctive activity would therefore fail to attain its natural goal.

"Fabre would have us see in this behavior the direct intervention of the finger of God. Bergson likens the powers displayed by the wasp to the skill of the surgeon, combined with the insight of the physiologist and the knowledge of the comparative

[1] McDougall, *Outline*, pp. 83-84. [2] *Ibid.*, p. 86.

anatomist; and he would explain this remarkable action by ascribing to the wasp an instinctive sympathy with the victim which teaches her just where the caterpillar is most vulnerable.

"It seems to me that both of these eminent authors, in their enthusiastic admiration for the action of the wasp, have neglected to contemplate the action from the point of view of the caterpillar. However that may be, further study of this behavior has shown that neither Fabre's description nor Bergson's interpretation was strictly scientific; that the former was biassed by a theological conviction and the latter by a philosophical theory. For Mr. and Mrs. Peckham have observed and described this behavior of *Ammophila* with minute care and admirable impartiality.[1] Their description shows clearly, (1) that the wasp does not always sting her prey precisely in the ganglia, but rather that, standing over her prey, she plunges in her sting at the joints between the segments where the cuticle is least resistant, and on the under side, where the sting most naturally comes in contact with the caterpillar (given the position of the wasp standing over her prey); and that she repeats the sting a variable number of times, in a somewhat irregular and variable series of spots; (2) that the caterpillar sometimes is not merely paralyzed, but killed; and in other instances is neither killed nor lastingly paralyzed, and that in either case the grub thrives upon its flesh, with seeming indifference to its putridity or its writhings.

"The Peckhams' account is valuable also as refuting the theory of the chain-reflex. If Fabre's description were accurate for all cases, if the wasp always held and stung the caterpillars in exactly the same way, with the same sequence of movements, it would be plausible to interpret this series of movements as a series of chain-reflexes. But if (as the Peckhams' account shows to be the case) different individuals and the same wasps on suc-

[1] Dr. McDougall refers to page 25 of their *Wasps, Social and Solitary*, 1905.

cessive occasions master the caterpillars by movements which are different in their sequence and direction on each occasion, the theory of the chain-reflex must appear less plausible; for this theory presupposes just such machinelike precision, regularity, and constancy of movements as Fabre has described.

"Consider another instance in which the Peckhams have supplemented the description of Fabre, with disconcerting results for him, for M. Bergson, and for the chain-reflex theorists.

"Fabre has described how the wasp of a certain species, on bringing her prey near the nest in the ground which she has prepared, invariably lays it down near the entrance, enters the hole without it, and after a few moments emerges to seize her prey again, and drags it into the nest. On one occasion Fabre made the following experiment: As soon as the wasp had entered her nest, leaving her prey near the entrance, he removed the prey a short distance from the hole. The wasp came out, searched for her prey, and, having found it, dragged it once more to the mouth of her burrow, and again entered, leaving it at the mercy of the observer. Again he removed it to a little distance. Again the wasp emerged, sought and found her prey, and left it close to the entrance, while she performed the instinctive ritual of entering the nest 'empty-handed.' And this was repeated many times; until the patience even of Fabre was exhausted, and the wasp had her way. Oh, wonderful and inscrutable instinct! How radically different from and incompatible with all intelligent action! Shall we call it, with Fabre, the working of the finger of God; or, with the mechanists, an illustration of the chain-reflex principle? Or shall we, with Bergson, see in it an example of the complete divorce in the insects of Instinct from Intelligence? But wait! the facts are not all in.

"The Peckhams repeated the experiment with a wasp of the same species. At first the result was the same. But the observers persevered again and again; and, after many repetitions of

the comedy, the wasp at last omitted the 'ritualistic' act, dragged her prey to the opening and, without laying it down, drew it into the nest. Oh, admirable co-operation of Intelligence with Instinct! After so many repetitions of the unintelligent instinctive routine, a little spark of Intelligence at last stirs, breaks through, and gives to Instinct just that help without which Instinct so often would fail. . . .

"One more example from the repertoire of the admirable *Ammophila*. This wasp makes her nest at the bottom of a sloping burrow dug in the earth. When she has deposited in it her egg and the necessary caterpillar (dead or alive, paralyzed or writhing), she proceeds to fill up the hole by tearing down loose earth from the walls and raking particles from the surrounding surface of the ground. When she has thus filled the hole flush with the surface, she smooths it off neatly, so that neither mound nor hollow remains, stamping down the loose earth. On one occasion the Peckhams observed the following behavior: *Ammophila* had filled her hole, and the operation, the last of the cycle of activities, seemed to be nearly completed. She seized in her jaws a tiny pebble and with it pounded down the loose earth filling the mouth of the hole, repeating her strokes many times. Oh, wonderful *Ammophila!* What shall Fabre, or Bergson, or the mechanists say of this most irregular behavior, so upsetting to every theory — except the common-sense theory that Instinct and Intelligence co-operate most intimately and that, while the wasp has much Instinct, she has also some Intelligence. Here is *Ammophila* using a tool! A mode of behavior commonly regarded as the exclusive prerogative of man, and sometimes proposed as the defining mark of his species." [1]

I suppose that Dr. McDougall's theory of behavior might be stated something like this: The simplest organisms show the elements of purposive behavior even in their approximately

[1] McDougall, *Outline*, pp 87–91.

random movements. By natural processes these undeveloped forms of behavior develop into instincts, which are innate tendencies to act; and through intelligence these innate tendencies are made to serve the purpose of the individual. If the word "Entelechy" be substituted for intelligence, this description is not far removed from that of Dr. Driesch.[1] Moreover, if this guiding principle observed in all animal behavior is merely something not mechanistic, is akin to our conscious processes but is not necessarily "soul," then it is very similar to the picture drawn by Mr. C. Lloyd Morgan, who holds that mechanism exists but that in the organism teleology acts on mechanism.[2] With this view, I suppose, Mr. J. Arthur Thomson, Mr. Hobhouse, and in a certain sense Mr. Alexander would all agree.[3]

Sir Charles S. Sherrington expresses the belief that the further application of physics and chemistry will furnish a key to many processes in the living body, such as muscular contraction, circulation of the blood, respiration, and the nature of the nervous impulse. But he admits that we are at a loss to understand the development of the individual from the egg, the predetermined term of natural existence, and how a divided nerve grows from its point of severance perhaps to some far-distant muscle, where it pierces the covering membrane and re-forms with the muscle its characteristic pattern. When we come to the relation of mind to brain, advance in science does not enlighten us; nevertheless, the human organism is in some way a whole. Can we suppose a unified entity which is part mechanism and part not?[4]

[1] Driesch, *The Science and Philosophy of the Organism*, 1908, pp. 52–122.

[2] Morgan, *Instinct and Experience*, 1912, especially p. 286. Cf. his *Emergent Evolution* (Gifford lecture, 1922).

[3] Thomson, *The System of Animate Nature*, 1920; L. T. Hobhouse, *Development and Purpose*, 1913, and *Mind in Evolution*, 1915; S. Alexander, *Space, Time, and Deity*, 1920. See also E. S. Russell, "Psychobiology," Aristotelian Society, *Proceedings*, 1922–1923, pp. 141–156.

[4] Sherrington, "Some Aspects of Animal Mechanism," British Association, *Report*, 1922 (the presidential address).

Of the idealist, or panpsychic, account of animal motion I wish at present to say nothing, but to it we shall return. However, a few words on the objective criterion of purposive behavior are necessary, and a brief comment on Dr. McDougall's statement that the behavior of animals, including man, is impossible on a mechanistic assumption will not be out of place.

For purposes of illustration let us take an example mentioned by Dr. McDougall. "The mechanist may be disposed to challenge also my statement that the reflex process does not exhibit variation of character and direction. He may point to the much celebrated instance of the brainless frog which, if a bit of blotting-paper soaked in vinegar is placed on one flank, will wipe it away with the hind foot of the same side, and which, if that hind foot is forcibly restrained, will wipe it away with the hind foot of the other side. In face of this instance (and of similar instances) we must admit that we cannot interpret the facts confidently. But there are two alternative interpretations, either of which is consistent with the distinction between reflex and purposive action which I have drawn. First, it may be that this is a true reflex action, mechanically explicable; that is to say, it may be that the resisted contractions of the leg, first excited reflexly by the stimulus, give rise to additional stimuli which provoke reflexly the movements of the other leg, or determine the excitement from the irritated spot to flow over to the other leg. If this is the true interpretation of this movement, it remains an interesting example of complicated reflex action. Secondly, it may be that the action is purposive in a lowly sense. When we deal with animals so low in the scale of life as frogs, we cannot argue safely from their anatomy to their functions. The brain of the frog is but very little developed; and a little lower in the scale we find animals which exhibit behavior in spite of having no brains, as we shall presently see.

It may be, then, that at the level of organization of the frog, the brain is not essential to purposive action — as it seems to be in animals higher in the scale of life."[1]

Here we have apparently an example of purposive action which may be interpreted, even according to Dr. McDougall, as a reflex. It may also be described as purpose. If it is conscious purpose, then spinal ganglia must in some cases be conscious, and so also must single nerve-cells; and, if one accepts the view that single cells are evolved from the inorganic, it is difficult to maintain that purposive action does not belong in the inorganic world too.

If this reflex is not purposive, why may not all apparently purposive action be of this kind? Why may not purposive action in ourselves be this kind of a reflex, but more complicated? And why may not consciousness be a mere spectator and the efficacy of purpose mere illusion? Here is just the point at issue. By analogy we attribute to actions in the external world consciousness and purpose when we think they are analogous to what we observe in ourselves. If we think that purpose acts in ourselves, then we attribute purpose to the world. But the whole affair may conceivably be stated as mere mechanism. Purpose as an objective criterion of the action of mind involves the assumption that purpose is active in us. How can we show that purpose is thus active? Of course my answer is that we can conceive of no activity other than purpose; but this rests on philosophical, not on strictly scientific, reasoning. All we can say is that, if purpose acts in us, it probably acts in animals. But if we deny that purpose acts in us, then it is conceivable, on the scientific assumption of matter independent of mind, that all action is mechanical. Purposive or intelligent action does not furnish an objective criterion of the action of mind unless

[1] McDougall, *Outline*, pp 55–56.

it has been previously shown that purpose is active in the world.

Let us return to our example of the homing of bees. There is no doubt that Dr. McDougall overthrows the specific mechanistic explanation of Bethe, and it is certain that his examples of the instinctive action of bees and wasps show that they exhibit the same kind of conduct which we observe in ourselves and call intelligent action. I think also there is no doubt that his analysis of instinct is in the main correct. I should also agree that conduct cannot be explained without introduction of the concept of purpose. I believe, however, that the necessity for the introduction of this concept rests on a criticism of the mechanistic theory and its application to empirical facts. Therefore, admitting the general scientific assumption, I think it is ideally possible to explain intelligent action in physicochemical terms. For example, it is possible to say that wasps, when they first emerge from their nests, have a definite physical constitution. Gradually, as they walk and fly about the nests, rays of light and other physical stimuli alter this physical constitution until there is stored up in their organization a new physical substance which causes them to react differently to their surroundings than they did before they had had any experience. This new physical substance gives them the power of finding their way back to the hives by means of a series of chain-reflexes, and exhibits behavior which, when observed in ourselves, we flatter ourselves is intelligent. An extension of some such description can, it seems to me, conceivably be held by the mechanist, in so far as no other concepts intervene, to furnish intelligible explanation of all behavior.

So the results from this long discussion of organic function are briefly as follows: (1) There is a whole lot of evidence which tends to show that the laws of the organic and the inorganic are

essentially the same. This does not prove that the inorganic is material and is wholly governed by mechanical laws; it may be that the organic and the inorganic are similar because the inorganic is undeveloped mind. (2) Throughout our examination it is evident that two points of view in regard to the explanation of organic functions are held: (*a*) that both the world and the organism are physico-chemical processes; (*b*) that the organism cannot be entirely explained as a physico-chemical process, but includes other categories usually described as teleological. (3) There remains a possible view, which has not been especially emphasized, that all reality may be a mental process.

You will remember that we are studying the theory of evolution with a definite purpose in view, that of reconciling the teleological and mechanistic interpretations. These experiments on organisms and the observed facts about them are necessary preparations for the understanding of the theory of evolution and of the relation of man to nature. At present the only remarks necessary about the significance of these facts are that they do conceivably show how organisms could have been evolved from the inorganic; that they show that organisms have much in common with the inorganic, and that the inorganic has much influence over conduct and apparently over our thoughts; that they give great weight to the contention that all reality is of the same kind of stuff; and that they do not prove that reality is matter. We have also seen that the interpretation of these facts exhibits marked differences, one school holding that all may be explained in physical terms, the other that some principle akin to purpose and involving something like intelligence must be introduced. These two opinions are so insistent, and both have so much authority back of them, that it would appear as if both contained truth. It would seem that some deep-lying reason were at the base of their irreconcilability, and that very possibly this reason may be found to exist in a wrong state-

ment of the ultimate concept of science. A satisfactory theory of evolution and a satisfactory theory of character must then combine and reconcile the two points of view, and must state in some intelligible manner the connection between what is ordinarily called the physical and the non-physical. This task is best postponed until we have finished our examination of the concrete facts.

CHAPTER XVII

ORGANIC EVOLUTION

A. General Facts of Evolution

If the assumptions of mechanistic science are accepted, "it has become clear that life must be looked upon as the last stage of a series of consecutive changes which go right back to the origin of the starry worlds. Organic evolution, which is concerned with the development of life-forms on our globe, occupies only a relatively very small point in the line of evolution viewed as a whole. It acquires such an enormous importance for us, only because man is the final outcome of this evolutionary process, and this conclusion vitally affects our whole outlook of life, our moral standards, and practical endeavours."[1]

If we agree that organic evolution is only a moment in cosmic evolution, the demand for unity which underlies science as well as philosophy urges us to find some concept that shall include all evolution. This demand for unity is what science means when it appeals to the uniformity of nature, when it demands that there shall be only as many principles of explanation as are indispensable. So this is what most theories of evolution try to accomplish; they attempt to state all evolution as one process, and they do this sometimes by ignoring facts, especially the facts of consciousness. It is, moreover, true that the theory of evolution which we adopt influences our whole outlook on life; hence it is necessary to guard against errors like those of Herbert Spencer, who founded his biology, psychology, and sociology on the theory that the fittest survive and on the assumption that acquired characters are transmitted.[2]

[1] S. Herbert, *The First Principles of Evolution*, 1913, p. 48.
[2] Henri Bergson, *L'évolution créatrice*, p. 85.

Romanes has insisted that there is a distinction to be drawn between "the fact of evolution and the manner of it."[1] Evolution, in the sense of a gradual transformation of one form into another, or in the sense that man has evolved from a long line of ancestors extending back to such primitive forms as single-celled organisms, is generally held to be an established fact.[2] The proofs of this gradual transformation are derived from (1) comparative anatomy; (2) embryology; (3) paleontology; (4) geographical distribution; (5) experimental breeding or genetics. Since the evidence is accessible to all we shall not enumerate it.[3]

Although there is general agreement on the broad fact of transformation, there are difficulties in describing the specific facts as well as the manner of this transformation. Since descent is acknowledged, we should be able to trace the line of descent of man from lower forms; but even this has not been done to the satisfaction of all. While descent can perhaps be traced in some limited instances, as for example in the horse, "it is quite another thing with phylogeny on the larger scale. Far more eloquent than any amount of polemics is the fact that vertebrates, for instance, have already been 'proved' to be descended from, firstly, the amphioxus;[4] secondly, the annelids; thirdly, the *Sagitta* type of worms; fourthly, from spiders; fifthly, from *Limulus*, a group of crayfishes; and sixthly, from echinoderm larvæ. That is the extent of *my* acquaintance with the liter-

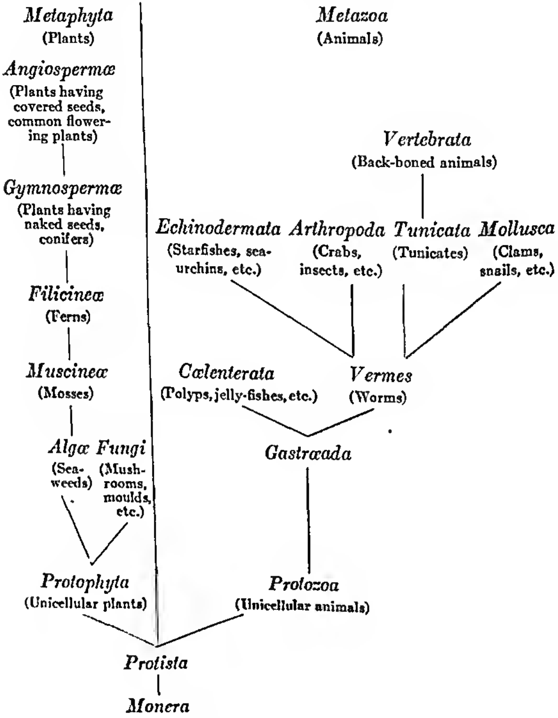
[1] G. J. Romanes, *Darwin and after Darwin*, 1892, i, 12.

[2] Herbert, *The First Principles of Evolution*, p. 51. Cf. also Hans Driesch, *The Science and Philosophy of the Organism*, 1907, pp. 250–251, 292; Max Verworn, *Allgemeine Physiologie*, 1915, pp. 28, 228–229; William Bateson, *Problems of Genetics*, 1913, p. 248; T. H. Morgan, *A Critique of the Theory of Evolution*, 1916, p. 38; R. S. Lull, "The Pulse of Life," in *The Evolution of the Earth and its Inhabitants*, 1920, p. 140; also his *Organic Evolution*, 1929, p. 99; H. F. Osborn, *The Origin and Evolution of Life*, 1916, pp. viii–ix.

[3] Herbert (*First Principles of Evolution*, pp. 51–106) and T. H. Morgan (*Critique of the Theory of Evolution*, pp. 7–27) give good summaries.

[4] The lancelet fish.

ature, with which I do not pretend to be specially familiar." [1] Nevertheless, an attempt to construct this genealogical tree is instructive if not taken too literally. The scheme given by Verworn is perhaps as good as any:—[2]



[1] Driesch, *The Science and Philosophy of the Organism*, 1907, p. 257. Cf. Osborn, *The Origin and Evolution of Life*, p. 130.

[2] Verworn, *Allgemeine Physiologie*, 1915, p. 389. (Reproduced by courtesy of Gustav Fischer, Jena.)

This scheme is sometimes put in the shape of a tree in which some early single-celled form is the root; from this root the tree grows, developing into plants and animals, each of which keeps branching.[1] But such a picture is misleading; for the actual course of evolution seems to be a path that divides into all kinds of blind alleys — insects, mollusks, and echinoderms. Some of the earliest forms persist unchanged to the present day, others die out; moreover, the path seems to twist and turn and even to turn back,[2] like the meanderings of a blind person in a forest.[3]

There is another aspect of organic evolution that is sometimes lost sight of. Not only is the process of evolution like the progress of a blind man in a forest, but it is marked by au appalling prodigality, as if the individual life in itself were of no account, as if there were merely a blind striving to live. Thus a herring produces 40,000 eggs a year, the fern *Aspidium filix mas* 14,000,000, the tapeworm 100,000,000.[4] Woodruff, in his study of *Paramecium*, in five years got 3029 generations, which were as healthy at the end of the culture as at the beginning and had shown the potentiality of producing a volume of protoplasm equal to ten thousand times the volume of the earth. "It has been estimated that at the end of the 9000th generation the mass would exceed the confines of the known universe and the rate of growth would be extending its circumference into space with the velocity of light!" [5] And it must be confessed that this tendency is not confined to the lower organisms. Such inconceivable increase is of course prevented by the fact that an organism lives by destroying other organisms, so that life is at least in part a continual fight to preserve itself against other forms of life.

[1] Herbert, *The First Principles of Evolution*, p. 86.

[2] Osborn, *The Origin and Evolution of Life*, p. 158 (for further illustrations see the index); Bergson, *L'évolution créatrice*, p. 113.

[3] Cf. August Weismann, *The Evolution Theory*, 1904, ii, 386.

[4] *Ibid.*, i, 46–48.

[5] R. S. Lull, *Organic Evolution*, 1920, p. 104. (Quoted by courtesy of The Macmillan Company, New York.)

Another very general aspect of evolution is of interest. We have seen that very early in history plants branched from the line of animal evolution. This branching was fatal, for nevermore could a plant return to the path taken by the animal kingdom. This branching without the possibility of return was repeated many times in both plants and animals, — in jellyfishes, insects, mollusks, and echinoderms, and in the various kinds of vertebrates and invertebrates. Moreover, examples of many of the earlier forms have persisted to the present day, — bacteria, protozoa, jellyfishes, worms, mollusks, and many species of vertebrates and invertebrates. Thus the world is peopled not only by the highest product, man, but also by survivals in the bacteria of very early and very undeveloped forms, and by all sorts of intermediate arrested developments, — amœba, radiolaria, fishes, reptiles, insects, birds, kangaroos, monkeys, and what not. Everything survives that by any possibility can.

One other very general aspect of evolution must not be overlooked. All theories start with a simple organism and result in a complex one, man. Whatever may be said of the lower forms of life, it is an observed fact — obtained by another method of observation, that of introspection — that there exists in man something which can only be described as conscious thought. Any theory of evolution that fails to account for this phenomenon will, in my opinion, eventually perish.

But, in spite of hesitations and wanderings, evolution does on the whole proceed in a main line from amœba — or from several species of simple organisms — to man, although the specific steps are difficult to trace. From the vertebrates on, the task is somewhat easier, but even here many matters are in dispute. Primitive, shark-like fishes of the Upper Silurian time,[1] perhaps 24,000,000 years ago, gave rise to early types of fringe-

[1] Osborn, *The Origin and Evolution of Life*, p. 167.

finned ganoids, which gradually acquired the power of locomotion on dry land,[1] thus becoming in the Upper Devonian time the ancestors of the amphibians. The evolution of amphihians, beginning perhaps in the Devonian period, extended through the swamp- and coal-forming period of the Carboniferous, which was especially suited to these types.[2] From the amphibians, or from common ancestors, were descended the reptiles of extremely diverse types, the evolution of which occupied a period extending from 15,000,000 to 20,000,000 years.[3] The most notable individuals in this complex reptilian society were those remarkable pro-mammalian types of reptile (cynodont, theriodont) from which our most remote ancestors, the stem-forms of the mammals, the next higher race of vertehrates ahove the reptiles, were destined to spring. The pro-mammals had marked development of all four limhs, their teeth were adapted to different kinds of food, and they may have heen warm-blooded.[4]

Out of the eighteen reptilian hranches only five survived into Tertiary times — "the orders which include the existing turtles, tuateras, lizards, snakes, and crocodiles";[5] and the development of these orders was extremely slow, if not entirely arrested, during the whole Tertiary time, a period of perhaps 3,000,000 years.[6] Among them were reptiles of a terrestrio-arboreal type which probably gave rise to birds and to the ancestors of mammals.[7] Of the latter there were three main branches: the primitive egg-laying mammals, Monotremata, the spiny ant-eaters of Australia and New Guinea; Marsupialia, the pouched mammals of Australia and the arboreal opossums of South America; and Placentalia, of which the tree-shrew is

[1] Osborn, *op cit*, p 174, Lull, *Organic Evolution*, pp 480–487

[2] Osborn, *op cit*, p 177, Lull, *op cit*, pp 480–487

[3] Osborn, *op cit*, pp 184–185, 193, Lull, *op cit*, p 497

[4] Osborn, *op cit*, pp 191–192, Lull, *op cit*, pp 539–541.

[5] Osborn, *op cit*, p 194

[6] *Ibid*, p 231

[7] *Ibid*, pp 227, 234–235, Lull, *op cit*, p 532

probably akin to the tree-living insectivorous mammals from which both whales and man were derived during a process of about 10,000,000 years.[1] The arboreal ancestors of man were perhaps lemur-like animals[2] that gave rise to monkeys, gibbons, our cousins the anthropoid apes, to the unknown Pliocene ancestors of man that date from the first Glacial stage, perhaps 500,000 years ago, and to the apelike creatures typified by *Pithecanthropus* of the Trinil race (470,000 years) and by the Heidelberg man (400,000 years). These primitives were succeeded by the Piltdown and the pre-Neanderthaloid man, the narrow-heads (150,000 years); by the Neanderthal man (50,000 years); and by the Crô-Magnon, or broad-heads, the Alpine stock, the Brünn, the Mediterranean (25,000 years).[3] It must not be understood, however, that the descent of any one of these races can be traced back in a direct line, — that the Crô-Magnon, for example, is the lineal descendant of *Pithecanthropus*. The evolution of man cannot be traced to the evolution of a single race, for the races were changing; one race replaced another, two races dwelt side by side.[4] Moreover, the figures given are merely rough guesses that serve only to give some idea of the relatively long early development and the short later development.

It is evident that even in this description of the general facts of evolution many gaps exist, many difficulties arise; yet we are able to make a vague picture of organic evolution from some simple, one-celled form to man. But when we try to explain how evolution came about we are lost in a sea of conflicting theories, enveloped in a fog of ignorance; so that Bateson, Os-

[1] Osborn, *op. cit.*, pp. 234–238; Herbert, *The First Principles of Evolution*, p. 80, diagram; Lull, *op. cit.*, p. 669.

[2] Lull, *op. cit.*, pp. 613, 669.

[3] Osborn, *Men of the Old Stone Age*, 1914, pp. 21, 23, 49–60; Lull, *op. cit.*, pp. 615–651, 671–676.

[4] Osborn, *Men of the Old Stone Age*, p. 501.

born, Lull, Driesch, Herbert, and Scott conclude that there is no theory that explains all the facts.[1] "Ideas which in the abstract are apprehended and accepted with facility fade away before the concrete case. It is easy to imagine how Man was evolved from an *Amœba*, but we cannot form a plausible guess as to how *Veronica agrestis* and *Veronica polita* were evolved, either one from the other, or both from a common form." [2]

It is clear that, if we wish to explain this transformation, we must be able to show how the amœba is able to change (the phenomenon of variation), and how the characters of the amœba were preserved and handed on to its descendants (the phenomenon of heredity). Or, as Bateson formulates the problem in terms of the origin of species, how does specific diversity arise? what part does environment play in causing these variations? and in what does specific fixity of type resulting from these variations consist? These questions lead us to the problems concerning heredity and variation and their relation to environment, upon the answers to which any theory of organic evolution depends.[3]

environment on development, both racial and individual. In discussing these questions there are again several purposes to be served. We wish to know the facts for further use, to point out that mechanical explanations of them are not universally accepted, and to show that the same opposition between teleology and mechanism is apparent here as elsewhere. Moreover, a theory of character must take cognizance of the empirical facts of heredity.

The evolutionary problem of development may be roughly summarized in the statement that development is the response of the germ to environment. The individual develops from a germ. We may, therefore, say figuratively and perhaps literally that the individual is a developed germ. Since, however, the word germ is usually reserved for the undeveloped individual, perhaps a better way to put the problem is, What determines the response of the individual to environment? But this response is intimately connected with the behavior of the germ, for it is clear that offspring inherit something and that they must get this something through the germ. It is also clear that individuals differ from their parents. If the theory is true that variations, new characters, must have originated in the germ, or at least have been impressed upon it, then in some sense the whole problem becomes, How does the germ preserve characters and transmit them, how does the germ vary, and what is the relation of the environment to these processes in the germ?

It may, however, be said with some degree of truth that the development of man is a non-biological problem; that, although he inherits certain gross traits, the general racial characteristics that are his biological heritage, yet his development is determined to a far greater measure by education. The word education is here understood to include not only traditions handed down in the form of institutions, moral and religious, but also the whole influence of his social environment. Moreover, man

is apparently able to suspend the course of natural selection through his control of environment. It is sometimes held that these factors separate him wholly from the beasts and make his development a non-biological problem. It is true that in human development aspects appear that are at least not common in the lower forms. Man can talk, and by the use of words he is able to preserve his past experience and to hand it on to his descendants in the form of a social heritage, which is to be distinguished from his biological heritage due to the germ. Furthermore, by the use of reason, which in its more highly developed form is largely dependent on words and symbols, he is able to control his environment to a considerable degree. These powers separate man from the animals by a great interval. But if one considers that such powers have been gradually acquired, — as Osborn shows in his *Men of the Old Stone Age,* Sollas in his *Ancient Hunters,* and Hobhouse in his *Mind in Evolution* and *Morals in Evolution,* — then one sees that they have been formed by a long process, that the difference between man and beast is one of degree, is great, to be sure, but is not a difference of kind.

It is also true, as we have said, that in human development the power of man to control environment introduces an element which in part suspends the operation of natural selection. But this fact, though introducing complications, does not seem to alter the fundamental fact that development depends on the response of the individual to environment. It does not seem to contradict the statement that the general process of human evolution is of the same nature as biological evolution.

To make this position clear we must anticipate somewhat. The facts of general organic evolution show that man is part of the animal kingdom; the facts of mental evolution show that his conscious powers are also a process of gradual evolution; the facts of the relation of body and mind show that the biological

and mental elements are inextricably interwoven. Moreover, whether man differs from the beasts in any essential particular, it is certain that he develops from a germ and that his mental powers do in some way result from this process of development. Thus in him we have the same general problem of the relation of the response of the germ to its environment. The fact that man has a social heritage can be stated so as to be wholly in accord with this view, for social heritage is merely a certain kind of environment. There seems, therefore, to be no special reason for considering the development of man as differing in kind from what we find in other parts of biology. Such a view must not be interpreted as meaning that man is to be reduced to the order of beasts, as an attempt to show that he has only tendencies to eat and multiply and fight. It is an attempt to show that nature is a continuous process which has thus far on earth resulted in man as its most precious product. It is not an attempt to explain the higher by the lower, as Mr. Bernard Bosanquet asserts; it is an attempt to state the relation of man to nature in some intelligible form, for man certainly has some relation to nature. Whether such an account belittles him and destroys ethics depends wholly on one's interpretation of nature, on what is meant by science. If science be interpreted to mean the laws of purposive action, then Bosanquet's whole criticism vanishes.[1]

We shall therefore try to discuss the problem of development as the problem of the relation of the germ, regarded as the carrier of hereditary traits that are present in the mature individual, to environment of whatever kind, external, internal, or social. Human development may be treated as a form of biological development different in degree and complexity but not in kind.

One word of caution before we proceed. Our philosophical

[1] Bernard Bosanquet, *The Philosophical Theory of the State*, 2d ed., 1910, ch. ii, especially pp. 22, 49-50.

discussion has made it improbable that physical reality is what orthodox physical science usually describes it to be. In discussing the organic functions we have used the ordinary physical terms. In speaking of the germ in heredity we shall continue to use these terms, but in the following sense: There is a something which we know as a germ-cell, and there is no escape from the fact that from this cell by a gradual process the mature individual results. We wish to describe this process in terms of the relation between properties of the germ and the environment, without committing ourselves to any theory as to what the germ really is. We wish to describe the way the germ behaves and to give some brief account of the various interpretations of this behavior. But we also wish to emphasize the fact that, although we use these physical descriptions, we are in no way committed by this use to a theory which holds that the development of the germ must be stated in mechanical terms. Any theory of development, idealistic or materialistic, must face the question of the relation of heredity to environment.

We have already seen that the development of the individual begins in the union of two cells, that this development is a response of powers of the cell to environment; but we have not reached a description and explanation of this process that is universally accepted. It is evident that through this germ-cell something is passed along from the parents to the offspring which preserves at least the general characters of the race. What is passed along by the germ-cells from parents to offspring is what is inherited, and we can best approach our problem by inquiring into the mechanism by which the determining factors are transmitted. As a preliminary step we must try to discover what kind of traits are passed along.

C. Heredity

Historically the study of heredity has concerned itself with the attempt to discover what individual traits are actually inherited and to find out what laws, if any, govern the inheritance of such traits. Much information has been collected by the efforts of Francis Galton and his followers,[1] and much also by the study of genealogies and experimental biology. A list of inherited traits that will show in part what has been accomplished includes stature; color of skin, hair, and eyes; shape of eyes, nose, and mouth; minute differences in length of the hair of the head and of the eyebrows; patches of parti-colored hair on the scalp; dimples. Johannsen has shown that seeds which differ in weight by only .02 to .03 grams transmit these characters, and Jennings in *Paramecium* found hereditary differences of .005 mm. in length. Cataract is inherited; the lens of the eye is only one three-millionth of the weight of the body, and sometimes in cataracts only one twentieth of the lens is covered. Even the size, number, and shape of cells in certain regions are inherited. Additions to our list would include polydactylism, syndactylism (webbed fingers and toes) and brachydactylism (short and stumpy fingers), achondroplasy (short and crooked limbs), myopia, glaucoma (swelling of eyeballs), and many other peculiarities. Tendencies to diseases, as to tuberculosis, longevity, obesity, baldness, hæmophilia, fecundity, feeblemindedness, genius, insanity, must also be included.[2]

The statistical study of inherited traits has formulated some very general laws. It seems that abnormal variations from the average of the race tend to revert; very tall fathers have shorter sons. This is the law of filial regression. It is, however, not

[1] Edwin Grant Conklin, *Heredity and Environment in the Development of Man*, 1915, p. 102.
[2] *Ibid.*, pp. 190–200.

inconsistent with the fact that we inherit from our ancestors, for on the average we have mediocre ancestors.[1]

Carl Pearson has shown that, if we select out the mediocre continually, we can get a race that approaches very nearly the higher stature of the race. It is doubtful whether we can breed up or down to the greatest extremes exhibited by a race, but we can change it so that it approximates very closely to a standard higher than its average.[2]

These statistical researches of Galton and Pearson have shown that every ancestor contributes to the inheritance of the traits of the individual, so that theoretically in fifty-seven generations from the Christian era each one of us would have 120 quadrillions of ancestors. This number is reduced, however, by the intermarriage of relatives. For example, Plate says the former German Emperor had only 162 ancestors in the tenth ascending generation instead of 512; and Pearson concludes, largely from studies of horses and dogs, that parents each contribute one half, grandparents one third, great-grandparents two ninths, and so on.[3] This is the law of ancestral inheritance; it is of course very general and applies only to great numbers.

But these statistical observations and laws serve chiefly to formulate the problem.[4] It is through the experiments of Gregor Mendel, rediscovered and supplemented by the work of De Vries, Correns, and Tschermak, that the greatest light has been thrown on the laws and mechanism of heredity.[5]

The Mendelian theory rests on these three principles:—

Every germ-cell carries pure "unit characters." This is the principle of segregation.

[1] Conklin, *Heredity and Environment*, p 218, Herbert, *The First Principles of Heredity*, 1910, pp 143–164

[2] *Ibid*, pp 168–170

[3] Conklin, *Heredity and Environment*, pp 215–217. [4] *Ibid*, p 222

[5] *Ibid*, p 224, Driesch, *The Science and Philosophy of the Organism*, 1907, pp 228–229, T. H. Morgan, *A Critique of the Theory of Evolution*, 1916, pp 41–42

The total heritage of an organism may be analyzed into unit characters which are inherited as a whole.

Often when contrasting unit characters are present in the parents they do not blend in the offspring; one appears, the other temporarily disappears. One character is then called "dominant," the other "recessive."[1]

Clear expositions of the principles of Mendelian heredity are given by Morgan and Conklin. "Let us turn to the demonstration of his first law — the law of segregation. The first case I choose is not the one given by Mendel but one worked out later by Correns. If the common garden plant called four o'clock (Mirabilis jalapa) with red flowers is crossed to one having white flowers, the offspring are pink. . . . The hybrid, then, is intermediate in the color of its flowers between the two parents. If these hybrids are inbred the offspring are white, pink and red, in the proportion of 1.2:1. All of these had the same ancestry, yet they are of three different kinds."[2]

Let us see how these laws apply to our example of the four o'clock. "The egg cell from the white parent carries the factor for white, the pollen cell from the red parent carries the factor for red. The hybrid formed by their union carries both factors. The result of their combined action is to produce flowers intermediate in color.

"When the hybrids mature and their germ cells (eggs or pollen) ripen, each carries only one of these factors, either the red or the white, but not both. In other words, the two factors that have been brought together in the hybrid separate in its germ cells. Half of the egg cells are white bearing, half red bearing. Half of the pollen cells are white bearing, half red bearing. Chance combinations at fertilization give the three classes of individuals of the second generation.

[1] Conklin, *Heredity and Environment*, pp. 250–251.

[2] Morgan, *Critique*, pp 41–42. (Quotations are by courtesy of the Princeton University Press, Princeton, N. J.)

"The white flowering plants should forever breed true, as in fact they do. The red flowering plants also breed true. The pink flowering plants, having the same composition as the hybrids of the first generation, should give the same kind of result. They do, indeed, give this result, i.e., one white to two pink to one red flowered offspring." [1] This illustrates the law of segregation, which holds that every germ-cell is "pure" with respect to any unit character.[2] Crosses of white and black Andalusian fowls show similar phenomena.[3]

Let us now take a third example illustrating the law of dominance and recession. "The third case is Mendel's classical case of yellow and green peas. . . . He crossed a plant belonging to a race having yellow peas with one having green peas. The hybrid plants had yellow seeds. These hybrids inbred gave three yellows to one green. The explanation . . . is the same in principle as in the preceding cases. The only difference between them is that the hybrid which contains both the yellow and the green factors is in appearance not intermediate, but like the yellow parent stock. Yellow is said therefore to be dominant and green to be recessive." [4] Morgan, however, thinks the terms dominant and recessive are of little importance, and he passes to the principle of unit character.

"Besides his discovery that there are pairs of characters that disjoin, as it were, in the germ cells of the hybrid (law of segregation) Mendel made a second discovery which also has far-reaching consequences. The following case illustrates Mendel's second law.

"If a pea that is yellow and round is crossed to one that is green and wrinkled . . . all of the offspring are yellow and round. Inbred, these give 9 yellow round, 3 green round, 3

[1] Morgan, *Critique*, pp. 43–44.
[2] Conklin, *Heredity and Environment*, p. 251.
[3] Morgan, *Critique*, p 45
[4] *Ibid*, pp 47–48

yellow wrinkled, 1 green wrinkled. All the yellows taken together are to the green as 3:1. All the round taken together are to the wrinkled as three to one; but some of the yellows are now wrinkled and some of the green are now round. There has been a recombination of characters, while at the same time the results, for each pair of characters taken separately, are in accord with Mendel's Law of Segregation. . . .

"We can, as it were, take the characters of one organism and recombine them with those of a different organism. We can explain this result as due to the assortment of factors for these characters in the germ cells according to a definite law. . . .

"The possibility of interchanging characters might be illustrated over and over again. It is true not only when two pairs of characters are involved, but when three, four, or more enter the cross.

"It is as though we took individuals apart and put together parts of two, three or more individuals by substituting one part for another.

"Not only has this power to make whatever combinations we choose great practical importance, it has even greater theoretical significance, for, it follows that the individual is not in itself the unit in heredity, but that within the germ-cells there exist smaller units concerned with the transmission of characters."[1]

So the essence of the Mendelian theory is that there are unit characters which are inherited as a whole and which may involve many different traits, as sex for instance may influence traits of body and of mind. These characters or groups of characters are united in the individual but are segregated in the germ. At times some of them manifest themselves to the exclusion of others, which may, however, reappear in a subsequent generation. Such persistent characters are dominants, the others recessives. We may now ask, Is all inheritance of this type? Are

[1] Morgan, *Critique*, pp. 52–54, 57–58.

all traits transmitted by units that are segregated? Can their inheritance be traced in accordance with the numerical principles of Mendel? Morgan and many others answer, Yes. "The discovery that Mendel made with edible peas concerning heredity has been found to apply everywhere throughout the plant and animal kingdoms — to flowering plants, to insects, snails, crustacea, fishes, amphibians, birds, and mammals (including man)." [1]

Possibly this view is somewhat extreme, for Dr. Conklin says: "The Mendelian principle of segregation has been found to be of such general occurrence that there is a strong inclination among Mendelians of the stricter sort to make it universal, and to explain all cases of 'blending' inheritance as due to incomplete dominance and to multiple factors. Whether or not such attempts may prove completely successful it is still too soon to say." [2] Mr. Bateson holds that intermediate types do not disprove the Mendelian theory, for "the progress of research has gone steadily to show that facts of heredity which at first seemed hopelessly complicated can be represented in terms of a strict Mendelian system. This simplification of the problem has far exceeded our earlier anticipations, and I have to regret that in dealing with several sets of phenomena I countenanced non-Mendelian interpretations which in almost every case it has been found possible to replace by simple Mendelian formulæ. Where this reduction to a common plan has not been yet effected, the difficulty, we feel fairly confident, is *generally* created rather by the disturbance of environmental causes or by the influence of undetermined factors than by any more profound aberration in physiology." [3] And Dr. Driesch: "And so we have at least an inkling of what the material continuity of inheritance

[1] *Ibid.*, p. 89.

[2] Conklin, *Heredity and Environment*, p. 287. (Quotations are by courtesy of the Princeton University Press, Princeton, N. J.)

[3] Bateson, *Mendel's Principles of Heredity*, 1909, pp. 215–216.

is to mean, though, of course, our 'single and separate morphogenetic agents,' or 'units' or 'allelomorphs' are in themselves not much more than unknown somethings described by a word; but even then they are 'somethings.'"[1]

We have seen that, very likely in accordance with the principles of Mendel, all organisms inherit definite characters. Such an assertion presupposes some common process in all organisms that is sufficient to explain this phenomenon.[2] In the higher organisms this common process is furnished by the processes ensuing on the fertilization of the egg, which involve the behavior of the chromosomes; and there is much evidence that points to the chromosomes as the bearers of the Mendelian unit characters. Therefore some authors apparently hold that they are the exclusive agents in heredity.[3] The evidence in support of the theory that the chromosomes are the bearers of these unit characters is briefly as follows: (1) Chromosomes come in approximately equal numbers from father and mother; half of the paternal and half of the maternal chromosomes are distributed to each cell of the organism.[4] (2) In the formation of egg-cells and sperm-cells the number of the chromosomes is reduced one half, but is restored by fertilization.[5] (3) "The association, distribution and segregation of Mendelian factors and of maternal and paternal chromosomes are exactly parallel. This is strong evidence that these factors are associated in some way with the chromosomes."[6] (4) "Boveri has studied the abnormal distribution of chromosomes to different cleavage cells in doubly fertilized sea urchin eggs and has found evidence that the heredi-

[1] Driesch, *The Science and Philosophy of the Organism*, 1907, p. 231.
[2] Morgan, *Critique*, p. 89.
[3] Osborn, *The Origin and Evolution of Life*, p. 98.
[4] Conklin, *Heredity and Environment*, p. 164; Wilson, *The Cell in Development and Inheritance*, 1919, pp. 67, 205.
[5] Conklin, *Heredity and Environment*, p. 105; Wilson, *The Cell*, etc., p. 205.
[5] Conklin, *Heredity and Environment*, p. 165.

tary value of different chromosomes is different."[1] (5) It has been shown that determination of sex, with its many connected characters, is probably due to an accessory chromosome.[2]

In many animals and probably in man some sperm-cells contain an accessory chromosome while others do not. Wilson discovered that in certain bugs the ova always contain the accessory chromosome but that only half of the sperms do; if an egg is fertilized by a sperm with an accessory chromosome, females result. He further discovered that eggs have a large accessory chromosome, while the sperms have either a large or a small one; if an egg is fertilized by a sperm having a large X chromosome a female is produced, if by one with a small Y chromosome a male is produced. In some cases the accessory chromosome is attached to an ordinary one, as in *Ascaris*, where the ova have such an accessory but only half of the sperms possess it. Here sex is probably determined by the type of sperm. So also in the case of man, where some sperms have probably twenty-four, others twenty-three chromosomes, while all the ova have twenty-four. Thus a female is produced by an egg and a sperm having each twenty-four chromosomes, a male by an egg bearing twenty-four and a sperm bearing twenty-three chromosomes.[3] "Similar correlations between chromosomes and sex have been observed in more than one hundred species of animals belonging to widely different phyla."[4]

But if chromosomes are bearers of heredity there must be smaller units in each chromosome; for the number of inherited characters is large, while that of the chromosomes is small. Morgan thinks he is able to show that each chromosome in the fruit-fly (*Drosophila*) carries characters that are inherited in a group, and that it is possible to localize in the chromosome what portion bears certain traits. The evidence for this localization

[1] Conklin, *Heredity and Environment*, pp. 165–166.
[2] *Ibid.*, pp. 166–167. [3] *Ibid.*, pp. 139–147. [4] *Ibid.*, p. 147.

is chiefly from sex-linked inheritance. Apart from the primary differences of sex, the reproductive organs, there are numerous secondary characters, as stature, hair on the face, voice. But there are even more specific traits showing sex-linked inheritance, such as color-blindness, and hæmophilia (tendency to excessive bleeding after injury). Morgan, working with his flies, found at least twenty-five such characters.[1] He found, moreover, that, by breeding a white-eyed male with a red-eyed female, the inheritance of red or white eyes followed Mendelian laws and were just what would be expected if the sex chromosomes carry the determinants for these colors and if the egg carries a dominant factor for red. Thus all the females had red eyes and half the males had red and half white eyes.[2] Continuing his experiments, Morgan thought that he could localize in the chromosomes the portions definitely connected with certain traits, thus showing a connection between the smaller units that compose the chromosomes and the smaller hereditary characters.[3]

Now, it is a matter of observation that not only do species and varieties differ but so also do individuals in the species, hence it is probable that no two individuals are physiologically alike; from this it follows that no two germ-cells are exactly alike.[4] The question occurs, then, Do combinations of chromosomes give a material basis for all these individual differences? In the white race there are probably forty-eight chromosomes and in the fertilized egg there are twenty-four pairs, half from each parent. Now, the possible combinations of these pairs would give 16,777,036 types of eggs, and after fertilization there could

[1] Morgan, *Critique*, pp. 99–109, 135; Conklin, *Heredity and Environment*, p. 272.

[2] Morgan, *Critique*, pp. 118–127.

[3] *Ibid*, pp. 91, 127–144; Conklin, *Heredity and Environment*, p. 274. Cf. A. Weismann, *The Evolution Theory*, 1904, ii, 113–135 (lecture xxv, "Germinal Selection").

[4] Conklin, *Heredity and Environment*, pp. 151–157.

be three hundred thousand billion.[1] But there are smaller units than chromosomes. A molecule of albumin contains forty carbon atoms, and in protoplasm there are many kinds of proteins or albumin, some molecules of which contain over seven hundred atoms. Thus the molecular constituents that go to make up the chromosome may be "well-nigh infinite." A unique material is necessary to explain organisms, and it is furnished by the structure of the chromosomes.[2]

While there is little doubt that the chromosomes and their parts furnish the basis for the inheritance of "unit characters," and while the Mendelian theory points out the way these characters are actually inherited, it is held with justice by many biologists that other factors than mere disconnected unit characters are involved in an inheritance. An organism is not only a lot of individual traits such as color of eyes and hair, shape of intestines and brain; it is also the combination of these into a whole. An organism is not merely a pack of cards, it is a unity. If it is regarded as a community of cells, it is true that these cells have different characters and functions, but it is also true that normally they all work for one end, the preservation of the organism and the race. This community of action or effort, whatever it may be called, must be transmitted by the germ. Perhaps the power may be described as the preservation of the broad racial character as distinguished from individual traits. There is considerable evidence tending to show that the physical basis for the inheritance of this racial character is furnished by the cytoplasm of the ovum; so Loeb holds that the cytoplasm of the egg may be regarded as the real embryo and that the chromosomes give it only its special characters.[3] Conklin believes that, although there is much evidence that the chromosomes are

[1] This applies apparently only to the female.

[2] Conklin, *Heredity and Environment*, pp. 155–156. Cf. Osborn, *The Origin and Evolution of Life*, pp. 97–98.

[3] Jacques Loeb, *The Organism as a Whole*, 1916, p. 246.

the special bearers of heredity, the cytoplasm determines such phenomena as polarity, which determines the behavior of the chromosomes, and symmetry, which determines the general form and localization pattern of the embryonic ectoderm, endoderm, and mesoderm in the cytoplasm of the oosperm, and that this determining power is derived from the ovum, not from the sperm.[1] Wilson apparently agrees that the cytoplasm is necessary for development, but holds that its action may be derived from the nucleus.[2] Verworn believes that the cytoplasm is essential to the various manifestations of life.[3]

Whether the chromatin is exclusively the bearer of inheritance or not, there is little doubt that the principles of Mendelian heredity hold very extensively and that the mechanism is in large measure furnished by the chromosomes. The laws of Mendelian heredity apply, whether chromatin or cytoplasm is the physical agent concerned. But are all the phenomena of heredity explained by Mendelian law and the mechanism of the chromosomes and cytoplasm? Let us go to an extreme and assert that Mendelian heredity is universal, and that the material basis for the transmission of all organic characters is furnished in the chromosomes and cytoplasm of the ovum. Is the whole fact of heredity thereby explained in mechanical terms? Besides the broad racial character there is, according to Driesch and Wilson, another element that is inherited. This is the general power of development from a germ to a complex individual. "What is the nature of this structure and how has it been acquired? To the first of these questions we have as yet no certain answer. The second question is merely the general problem of evolution stated from the standpoint of the cell-

[1] Conklin, *Heredity and Environment*, pp. 167–179.
[2] Wilson, *The Cell in Development and Inheritance*, pp. 423–424.
[3] Verworn, *Allgemeine Physiologie*, 1915, pp. 73–78, 101.

theory. . . . What lies beyond our reach at present, as Driesch has very ably urged, is to explain the orderly rhythm of development — the coördinating power that guides development to *its* predestined end. We are logically compelled to refer this power to the inherent organization of the germ, but we neither know nor can we even conceive what that organization is." [1]

Driesch, as usual, goes even farther and holds that the inherited power is non-mechanical. "We say it is a mere absurdity to assume that a complicated machine, typically different in the three dimensions of space, could be divided many many times and in spite of that always be the whole; therefore there cannot exist any sort of machine as the starting-point and basis of development.

"Let us again apply the name entelechy to that which lies at the very beginning of all individual morphogenesis.

"Entelechy thus proves to be also that which may be said to lie at the very root of inheritance, or at least of the outcome of inheritance." [2]

According to this view, therefore, there is apparently something passed along in heredity which is not material, not machine-like, but which governs the whole. But Morgan holds that this factor, which we call development, is not a problem of heredity, that all is passed along by the germ according to Mendelian laws which wholly explain the mechanism of heredity as such.[3] Even Loeb recognizes the inadequacy of Morgan's conception and asks if the organization is nothing but a mosaic of hereditary characters. What, then, *gives unity to this mosaic?* How can a factor contained in the chromosome influence bodily development? The cytoplasm of the egg gives the unity; and

[1] Wilson, *The Cell*, etc., p. 432.

[2] Driesch, *The Science and Philosophy of the Organism*, 1907, pp. 226–227.

[3] Morgan, *Critique*, p. 144.

fluids circulating in the organism, internal secretions, are the way the chromosomes work.[1] Loeb reviews the whole development of the organism from an egg, and concludes:

"The most important fact which we gather from these data is that the cytoplasm of the unfertilized egg may be considered as the embryo in the rough and that the nucleus has apparently nothing to do with this predetermination. This must raise the question suggested already in the third chapter whether it might not be possible that the cytoplasm of the eggs is the carrier of the genus or even species heredity, while the Mendelian heredity which is determined by the nucleus adds only the finer details to the rough block. Such a possibility exists, and if it should turn out to be true we should come to the conclusion that the unity of the organism is not due to a putting together of a number of independent Mendelian characters according to a 'pre-established plan,' but to the fact that the organism in the rough existed already in the cytoplasm of the egg before the egg was fertilized. The influence of the hereditary Mendelian factors or genes consisted only in impressing the numerous details upon the rough block and in thus determining its variety and individuality; and this could be accomplished by substances circulating in the liquids of the body as we shall see in later chapters." [2]

If a layman may be permitted to express an opinion, we may conclude that Morgan is undoubtedly right in his distinction between the problem of development and that of heredity. But if you hold that heredity in its totality is explained by the material units of the germ, you must hold that some material unit, units, or combinations are passed on by heredity sufficient to explain development and furnish the unity of the organism. This is possibly given in Loeb's account. But in man the result of the development of the germ is a conscious individual, and

[1] Loeb, *The Organism as a Whole*, pp. 244–245. [2] *Ibid.*, pp. 151–152.

as a matter of observation the conscious traits are the result of the union of two cells. At what stage in human development is consciousness formed? What potentiality in the germ gives rise to it? Can this potentiality be stated in mechanistic terms? It seems impossible to put the case otherwise than by saying that two germs have something which eventually leads to consciousness and that through the fertilization of the ovum these somethings fuse to form one. If you hold that all is physicochemical, you assert that consciousness in some way arises out of the material, — which seems impossible. In any case, in the germ this something that eventually gives rise to consciousness is passed along from parent to offspring. Can we say that a theory of heredity which does not explain this transmission is adequate?

Moreover, we have seen that both Driesch and Wilson hold that a mechanical explanation of development has not been reached; and with this statement Morgan agrees. So it would seem that, since the power of development is also handed on by heredity, from this point of view also the mechanism of heredity is not wholly solved. Further, in considering animal behavior, we made some mention of complex tropisms that pass over into marvellous instincts like those of bees and wasps. A physical basis for these is a possible conception; but when one tries to put into definite words how the germ preserves these instincts, in what specific part it keeps them, and how it passes them along through all its fusions and divisions, one finds the task extremely difficult.

There are some other aspects which, from a philosophical point of view, deserve mention as a matter of record. Driesch has pointed out that, from whatever point of view heredity is considered, it is a process without beginning, it is an infinite process.[1] In examining reproduction, we saw that cells are

[1] Driesch, *The Science and Philosophy of the Organism*, 1908, p. 181.

potentially immortal and that man's ancestry must reach back in an unbroken line to the first organism. If life is eternal, then this process of heredity implies the infinite; if it is produced from what we call the inorganic, it is likewise infinite. In either case heredity involves the handing down of processes of which there is no beginning, so that each individual stores up the results of an infinite process. It is very difficult to conceive this in materialistic terms.

Semon makes memory the basis of heredity, but Driesch holds that this conception is more difficult than that of mechanism. If memory is the basis of heredity, it must be memory of the germ; it must be held that whatever variations the germ itself is able to produce, whatever experience it is able to store up, is remembered by it and preserved. Such a view is not, as Dr. Angell asserts,[1] inconsistent with the non-heredity of acquired traits, as we shall try to show later. It has the advantage of making heredity intelligible by the operation of a process of memory with which we are acquainted, however mysterious this process of memory is in itself. Inheritance through memory is no more mysterious than the supposition of a substance in the germ that stores up an infinite process, that carries consciousness, that is able to guide the development of the organism into such complex reactions as are necessary to the writing of these pages.

In view of these conflicting opinions, and of the perhaps philosophical rather than strictly scientific fact that the possibility of development must somehow be latent in the germ and that the general process of heredity implies infinity, we may perhaps conclude that the chromosomes are what are usually called the material bearers of individual traits and that the cytoplasm of the ovum carries the more general characters. When we ask for an explanation of heredity, we find differences of opinion sim-

[1] James Rowland Angell, "The Evolution of Intelligence," in *The Evolution of Man*, ed. G. A. Baitsell, 1922, p. 107.

ilar to those we have observed elsewhere. These opinions may be summed up under the headings of mechanism, ignorance, and teleology.

There are certain other aspects of development which are in one sense parts of the problem of heredity and in another sense special problems. There is, for instance, the question as to what determines the specific traits in the germ. Is it all heredity or is it in part due to environment? Intimately connected with this question is that of how variations arise. Are they caused by the germ, or by the environment, or by both? "Indeed, we may express the whole matter before us as essentially the problem of 'Heredity and Environment.'"[1] In a way the discussion of these matters will lead to digression from the special purpose of our examination, to a divergence from the question whether the observed facts about the organism can be explained in mechanistic terms. As our main purpose, however, is to furnish an intelligible foundation for a science of character, with the intent of ultimately determining the means for controlling the development of the individual and hence also of society, such an important practical matter as the relation between heredity and environment must not be omitted. Besides, the whole theory of organic evolution depends on an interpretation of variation, heredity, and environment. So, first of all, let us consider whether environment directly causes changes in the germ, so that new characters which are acquired during an individual's lifetime are impressed on the germ and transmitted to the offspring. This, I take it, is the problem of the inheritance of acquired characters.

[1] Herbert, *The First Principles of Heredity*, 1910, p. 178 (By courtesy of Messrs A. and C. Black, Ltd, London.)

CHAPTER XVIII

ORGANIC EVOLUTION

D. THE INHERITANCE OF ACQUIRED CHARACTERS

UNTIL Weismann published his essays on heredity it was generally supposed that new powers acquired by an organism were transmitted to its offspring. These new powers were the result of various environmental influences that brought about the continued use of an organ and improved it. Disuse of an organ caused deterioration which might also be transmitted. We have seen that this transmission takes place through the germ-cells. It becomes very difficult, then, to understand how an acquired skill — as, for example, skill in piano-playing — could cause a change in the germ-cells. So Weismann some forty years ago said: "Even the apparently powerful factors in transformation — the use and disuse of organs, the results of practice or neglect — cannot now be regarded as possessing any direct transforming influence upon a species. And the same is true of all the other direct influences, such as nutrition, light, moisture, and that combination of different influences which we call climate. All these, with use and disuse, may perhaps produce great effects upon the body (*soma*) of the individual, but cannot produce any effect in the transformation of the species, simply because they can never reach the germ-cells from which the succeeding generation arises."[1] This states the issue. Do such influences change the germ? There is much experimental evidence that is pertinent.

Tower, by experiments on potato-beetles, thought that he caused variations by breeding the beetles under various condi-

[1] August Weismann, *Essays upon Heredity*, etc., 2d ed., 1801, i, 390–400. (Quoted by courtesy of the delegates of the Clarendon Press, Oxford.)

tions of temperature and humidity, and that these variations were inherited. His experiments are apparently accepted by Conklin,[1] but Loeb holds that "they are not all beyond the possibility of error."[2] Bateson agrees with Loeb, and suggests that these variations may be merely due to Mendelian heredity.[3]

Kammerer experimented with several amphibia — toads and salamanders — under various conditions of temperature, humidity, and color environment, and he thought inheritable variations were produced. Of these experiments Loeb says, "While the writer does not decline to accept . . . Kammerer's statements in regard to the inheritance of acquired character, he feels that more work should be done before they can be used for our problem."[4] With this conclusion Conklin apparently agrees.[5] Bateson examines the experiments very critically and says that, until they can be repeated, he finds "it easier to believe that mistakes of observation or of interpretation have been made than that any genuine transmission of acquired characters has been witnessed."[6]

Dr. D. T. McDougall injected into the ovaries of the plant *Raimannia odorata* various substances, — a 10 % sugar solution, a $^1/_{10}$ % solution of calcium nitrate, radium, — with the result that new varieties arose. He also injected zinc sulphate into the ovaries of *Œnothera biennis* with similar results. Of these experiments Bateson says, "From the evidence, however, I am by no means satisfied that their original appearance was a consequence of the treatment applied."[7]

Conklin, referring especially to experiments by Stockard, who subjected male and female guinea-pigs to the fumes of alcohol

[1] Conklin, *Heredity and Environment*, 1915, p. 348.
[2] Loeb, *The Organism as a Whole*, 1916, p. 348.
[3] Bateson, *Problems of Genetics*, 1913, pp. 219–227.
[4] Loeb, *The Organism as a Whole*, pp. 337–341.
[5] Conklin, *Heredity and Environment*, pp. 350–351.
[6] Bateson, *Problems of Genetics*, pp. 199–211 (the quotation is on p. 211).
[7] *Ibid.*, pp. 227–229.

and maintained that these fumes produced weak and sickly offspring, concludes that there is much evidence that the so-called racial poisons cause changes in the germ which are inherited.[1]

Holmes examines the evidence for the true heredity of defects caused by alcohol, syphilis, tuberculosis, malaria, — so-called racial poisons: "It may be more or less probable, *a priori*, that they may permanently impair human germ plasm and give rise to strains with a degenerate inheritance, but our knowledge on this important problem is still too meager to justify positive statements." [2]

Bateson, referring to this kind of evidence, says: "The very wide departures from expectation shown in many pedigrees of human diseases and defects are certainly in part attributable to the imperfections of the records, but I cannot doubt that the discrepancies are in part due to genuine physiological causes. In regard to some of these it is, I think, still open to question whether the transmission is a process comparable with that which we ordinarily designate as Heredity. Some element is obviously handed on from individual to individual, but it seems to me possible that this element or poison is distributed irregularly among the germ-cells, spreading among them by a process which is mechanical, like the spread of an oil-stain in a heap of paper, or of a fungus in a heap of seeds. In the present state of pathological knowledge it is premature to make any suggestion as to the possible nature of such poisons. I am told by competent authorities that in the cases, for example, of the various polymorphic hereditary paralyses it is very improbable that pathogenic organisms can be the exciting cause; nevertheless, from a study of the inheritance in an ample series of families, I am inclined to suppose that the element transmitted is something

[1] Conklin, *Heredity and Environment*, pp. 310–311.
[2] Samuel J. Holmes, *The Trend of the Race*, 1921, p. 293.

apart from the normal organism, and that it is handed on by a process independent of the gametic cell-divisions. In such cases I do not anticipate that any 'law' of inheritance can be discovered, for if my view is correct, the process is not heredity in the naturalist's sense at all. . . .

"This group of cases introduces us to several points of interest. We have first the remarkable fact that the mother-plant can impress varietal characters on her offspring by influences which are not heredity in the ordinary sense. Seeds are in botany what larvæ are in zoology, and no example is yet known in which the maternal impress extends beyond the seed-stage. But without any serious stretch of imagination we may suppose that a maternal impress may be such as to produce an effect lasting at least for the life-time of the immediate offspring; and it would not be altogether surprising if such results were actually detected in the cases enumerated; for the difference in food-materials between those provided by a dent seed and a flint, a glutenous and a starchy, may, for aught we know, influence the later life of the plant, just as the nature of the milk supplied to the human infant is believed to do. Such influences may probably enough be limited and perhaps trifling in comparison with those that are in the strict sense genetic, but we do not yet know that they are negligible." [1]

According to Bateson, therefore, the influence of diseases and poisons on the offspring would be due to environmental conditions affecting the development of the individual, and would not be cases of true heredity at all.

That the germ-cells are influenced by environment very little if at all, and surely only after a long period of time, seems to some authors to be shown by the experiments of Castle and Phillips, who removed the ovary from a pure white guinea-pig

[1] Bateson, *Mendel's Principles of Heredity*, 1909, pp. 254, 264. (By courtesy of the University Press, Cambridge, England.)

(pure being understood in the Mendelian sense) and put in its place the ovary of a pure black animal. The white female with the black ovary was bred to a pure white male. Three generations of offspring were all black, black being a dominant character. The fact that they were bred in a white environment did not change their character at all.[1]

Payne bred sixty-nine generations of *Drosophila ampelophila* in the dark without producing any modification of the visual organs.[2]

Conklin, in summing up the evidence, says: "(1) Developed characters, whether 'acquired' or not, are never transmitted by heredity. . . .

"(2) Probably environmental stimuli acting upon germ cells at an early stage in their development may rarely cause changes in their hereditary constitution. . . .

"(3) Germ cells like somatic cells may undergo modifications which are not hereditary; they may be stained with fat stains and the generation to which they give rise be similarly stained; they may be poisoned with alcohol or modified by temperature and such influence be carried over to the next generation without becoming hereditary. All such cases are known as 'induction' and many instances of the supposed inheritance of acquired characters come under this category." [3]

Dr. William McDougall holds that the problem of the inheritance of acquired characters is unsolved.[4] Loeb says he is "not aware that there is at present on record a single adequate proof of the heredity of an acquired character."[5] And Bateson: "Abundant illustrations are available in which individuals exposed to novel conditions manifest considerable changes in

[1] Conklin, *Heredity and Environment*, pp. 341–347.
[2] Bateson, *Problems of Genetics*, p 220.
[3] Conklin, *Heredity and Environment*, p 351.
[4] McDougall, *Is America Safe for Democracy?* 1921, pp. 139–140
[5] Loeb, *The Organism as a Whole*, p 340.

characters and properties, but as yet there is no certain means of determining that germ-cells of a new type shall be formed."[1]

Professor George H. Parker, in a lecture for the benefit of the Radcliffe Endowment Fund, has called attention to three lines of research that emphasize the persistency of the germ-plasm and its enormous power in determining the development of the individual. The first of these three classes are the facts of Mendelian heredity, which show that individual traits are carried along by the germ unchanged for generations. The second is the experiment of Castle with the guinea-pigs, to which we have already referred. If a philosopher may intrude into biology, I should like to say that these experiments do not seem to be conclusive against the influence of environment on the germ; for, if you will recall Steinach's experiment, you will see that the ovary itself is a powerful environmental influence, that it is secretions from the ovary that determine in part the development of the body. So by transplanting black ovaries into white bodies possibly no real change of environment results. The third group of facts showing the power and persistence of the germ is furnished by the study of identical twins.[2] These, it is held, are formed by the separation of the impregnated ovum into two zygotes, which then form two individuals. The intensely minute power of the germ is shown by the fact that delicate marks like the pattern of the lines of the skin on the fingers, the fingerprints, are largely in their main aspects identical for both individuals.

But Wilder shows, in his *Palm and Sole Studies*, that this hereditary power of the germ is also limited to some extent. This we should expect, if variation is to arise. All the lines are

[1] Bateson, *Problems of Genetics*, p. 213.
[2] H. H. Wilder, "Duplicate Twins and Double Monsters," in *American Journal of Anatomy*, iii (1904), 387–472; Wilder, "Palm and Sole Studies," in *Biological Bulletin*, xxx (1910), Nos. 2 and 3; H. H. Newman, *The Biology of Twins (Mammals)*, 1917.

not reproduced, only the main ones. Moreover, there are in some cases marked variations. Thus, in a study of the prints of the four palms and four soles of duplicate twins, *seven* of the members show remarkable identity, but *one* shows equally pronounced variation. Variation and heredity both operate here as elsewhere.

In a suggestive article in *Harper's Magazine* for December, 1923, Dr. Ellwood Hendrick calls attention to evidence in favor of the hypothesis that traits acquired by the parents through their own activity are transmitted to offspring conceived while such activity is operative. Thus the offspring of white mice trained to respond to a bell are said to learn to respond to the bell quicker than their parents do. This may be true, but much work is necessary before such an hypothesis can be accepted as proved.[1]

But, even after all this discussion of acquired characters, there remains a pretty general feeling that in some way environment influences the germ in some other way than by calling forth its potentialities. Thus, Osborn holds that the facts of progressive adaptation imply law, and this must mean some kind of orderly change in response to environment. This need is especially emphasized by the paleontologists. Lull finds such influence largely in climate, but is confident that there is some relation between development and environment. Conklin believes that environment may change germ-cells in the early stages of their development. Semon and Osborn hold that this influence of environment may come through the mediation of the secretions of glands. Driesch apparently believes that the connecting link is found in entelechy; and J. Arthur Thomson holds that the connection is through a process of trial and error analogous to that exhibited by mind.

[1] Cf. Ivan Petrovitch Pawlow, "The Identity of Inhibition with Sleep and Hypnosis," in *Scientific Monthly*, December, 1923, pp 603–608.

The result seems to be that possibly, perhaps probably, certain environmental influences produce very slowly changes in the germ, but that there is at present so little proof of the inheritance of acquired characters that it is unsafe to base any theory of evolution or theory of character on such insecure foundations.

E. Mutations

The question as to the influence of environment on the germ leads naturally to the subject of "mutations." If we start with the assumption that the complex organism is formed from a single-celled organism, and that this is true from the point of view both of racial and of individual development, then we must formulate some description of the way in which the original cell can change. If we look at the facts of either class, we are of course led to the conclusion that this power exists in the cell. Eggs of different organisms in the same environment give rise to different organisms. If we look at the process of evolution, we must suppose that the original single-celled individuals from which man is derived got some new power different from that possessed by the ancestors of the amœba, which has not changed. The origin of this new power, this variation, may conceivably be accounted for by assuming that some of the cells of the original uni-celled creatures did not divide into mathematically equivalent parts. This fact that the two parts were different might, in the struggle for survival, conceivably have led to an advantage for one of the parts. Such advantage might possibly have consisted in a variation which led to reproduction by conjugation, in consequence of which, by a process of Mendelian heredity and crossing, it is within the bounds of possibility that the various species and individuals now present on earth could have resulted through the process of natural selection. Such an hypothesis is of course a mere guess;[1] but somehow variations

[1] Cf. Verworn, *Allgemeine Physiologie*, 1915, p. 220.

must have occurred, otherwise evolution is impossible. Let us therefore examine some of the theories that have been offered.

De Vries, chiefly by observations on the evening primrose (*Œnothera Lamarckiana*), thought he found certain new qualities carrying large variations which arose spontaneously, or rather through no known cause. These variations he called "mutations."[1] Bateson, who criticizes this theory at length, holds that nearly all of De Vries's "mutations" may be explained by Mendelian heredity, — that is, by the recombination of traits or by the loss of traits,[2] — and concludes, "If further we find that we have, with certain somewhat doubtful exceptions, never seen the contemporary origin of a dominant factor, or of inter-racial sterility between indubitable co-derivatives, it needs no elaboration of argument to show that the root of the matter has not been reached." [3]

Additional researches on *Œnothera* show that the normal number of chromosomes for the genus is 14, but that in various "mutants" this number is changed. Thus, *lata* has 15, *semilata* 15, *semigigas* 21, *gigas* 28.[4] Therefore Dr. Gates thinks that certain varieties of *Œnothera* show distinct mutations which cannot be accounted for on Mendelian principles, and decides that they depend on changes in the nucleus of the cell. "Such changes may be thought of as alterations in chemical structure or even in polarity, and may also be supposed to extend to the ground substance of the whole cell. But the real nature of all such changes as those last mentioned is at present highly speculative." [5]

T. H. Morgan shows that many variations do occur as an accompaniment of the recombination of Mendelian factors, and

[1] Bateson, *Problems of Genetics*, p. 101.
[2] *Ibid.*, pp. 99–102. [3] *Ibid.*, p. 249.
[4] J. A. Thomson, *The System of Animate Nature*, 1920, ii, 410.
[5] R. R. Gates, *The Mutation Factor in Evolution, with Particular Reference to Œnothera*, 1915, p. 303, quoted by Thomson, *System*, p. 415.

believes that in this way new factors may possibly be produced or old ones dropped out, and so mutations may arise. Moreover, he holds that mutations, in De Vries's sense, may occur spontaneously. The causes of the spontaneous variations we do not know.[1]

Driesch, after referring to Bateson and De Vries, says: "'Mutations' are known to exist at present only among some domesticated animals and plants. Nothing of a more general character can be said about their law or meaning." [2] With this conclusion, it would seem, we must for the present rest content.

But Thomson sums up his consideration of the whole problem in these words: "The position we are suggesting is that the larger mutations, the big novelties, are expressions of the whole organism in its germ-cell phase of being, comparable to experiments in practical life, solutions of problems in intellectual life, or creations in artistic life. . . . Is it fanciful to suppose that these gametes, neither simple cells nor portmanteaus of hereditary factors, but unified individualities, experiment internally, not fortuitously but artistically, not at random nor yet inexorably, not purposefully but perhaps purposively, and that they are body-minds or mind-bodies telescoped down?" [3]

Here again, in the problem of the origin of variations, we find the same views that have appeared elsewhere — a confession of ignorance, a mechanical view, a teleological view. But, although there is no generally accepted proof that the environment causes inheritable changes in the germ, there is much evidence that the environment does something; and this leads to the very interesting problem of the relation between heredity and environment.

[1] Morgan, *A Critique of the Theory of Evolution*, 1916, pp. 162–163, 194.
[2] Driesch, *The Science and Philosophy of the Organism*, 1907, p. 230.
[3] Thomson, *The System of Animate Nature*, ii, 430–453 *passim*.

CHAPTER XIX

ORGANIC EVOLUTION

F. Heredity and Environment

"If the leaves of a tree are arranged according to size (fig. 71), we find a continuous series, but there are more leaves of medium size than extremes. If a lot of beans be sorted out according to their weights, and those between certain weights put into cylinders, the cylinders, when arranged according to the size of the beans, will appear as shown in figure 72. . . . If we stand men in lines according to their height (fig. 75) we get a similar arrangement.

"The differences in size shown by the individual beans or by the individual men are due in part to heredity, in part to the environment in which they have developed. This is a familiar fact of almost every-day observation. It is well shown in the following example. In figure 76 the two boys and the two varieties of corn, which they are holding, differ in height. The pedigrees of the boys . . . make it probable that their height is largely inherited and the two races of corn are known to belong to a tall and a short race respectively. Here, then, the chief effect or difference is due to heredity. On the other hand, if individuals of the same race develop in a favorable environment the result is different from the development in an unfavorable environment, as shown in figure 78. Here to the right the corn is crowded and in consequence dwarfed, while to the left the same kind of corn has had more room to develop and is taller." [1]

Now, if in a community the taller men are selected for breeding, the average of their offspring will be taller than the average

[1] T. H. Morgan, *A Critique of the Theory of Evolution*, 1916, pp 147–152. (Quoted by courtesy of the Princeton University Press, Princeton, N J)

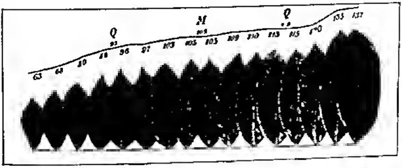


Fig 71. Series of leaves of a tree arranged according to size. (After de Vries)

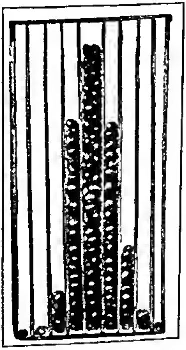


Fig 72 Beans put into cylindrical jars according to the sizes of the beans The jars arranged according to size of contained beans (After de Vries)

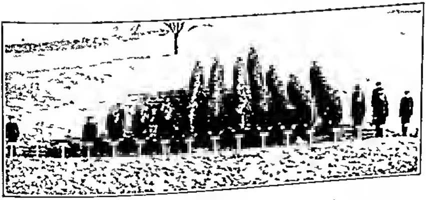


Fig 73 Students arranged according to size (After Blakeslee)

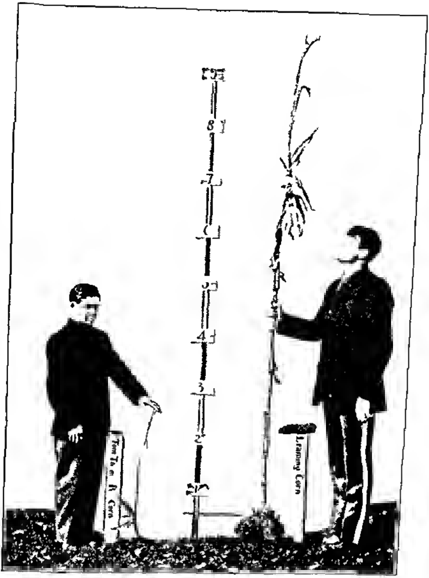


Fig 76 A short and a tall boy each holding a stalk of corn — one stalk of a race of short corn the other of tall corn (After Blakeslee.)

Fig 78 A race of corn reared under different conditions

of the former population. If this process of selection is continued, still taller men on the average will result. But soon the process slows down and a limit is reached. More tall men may be produced, but the tallest are not necessarily, or probably, taller than the tallest in the original population. Johannsen, working with self-fertilized beans, which give a pure race or races, found that a mixed population gave a number of pure lines; so that, no matter whether a small or a large bean in a given line were selected, the same racial characteristics would result. This tends to show that the variations in a pure line are due to environment and that the germ-plasm in each line remains pure and unaffected by environment.[1] Jennings got similar results in lines or races of *Paramecium*.[2] These examples show both that there is a limit to improvement of individual development by breeding and that environment plays a part.

In considering the transmission of acquired characters, we saw many instances of the action of stimuli on development which called forth changes in the reaction of the germ irrespective of the fact whether such changes were inherited or not. McDougall's experiments on plants point to the conclusion that chemical substances may so influence the ovules that individual development is modified; and these modifications are possibly transmitted to the offspring.[3]

As Bardeen and the Hertwigs have shown, great monstrosities may be produced by the action of X-rays or radium or various chemical substances on the spermatozoa before fertilization.[4]

Stockard believes that the influence of alcohol is deleterious to the sperms and ova of guinea-pigs and produces reduced fertility and excess of weak offspring.[5]

[1] Morgan, *op. cit.*, p. 159.
[2] *Ibid.*, pp. 181–182; Conklin, *Heredity and Environment*, 1915, pp. 378–379.
[3] *Ibid.*, p. 311. [4] *Ibid.*, p. 311.
[5] *Ibid.*, pp. 311–312.

"Gudernatsch found that if tadpoles of the frog were fed on the thyroid gland they transformed into minute frogs, scarcely larger than flies, but if fed on thymus gland they grew to be large, dark colored tadpoles but did not change into frogs; if fed on the adrenal gland they produced extremely light colored forms. If canary birds are fed on sweet red pepper they become red in color. If the larvæ of bees are fed on 'royal jelly,' which is a bee food rich in fats, they become fertile females or queens; if fed on ordinary 'bee bread' they become infertile females or workers." [1]

We have already referred to the experiments by Gudernatsch which show that the secretions of certain glands affect development. Similar experiments have been performed on young fowl with like results. The environmental stimulus of substances from the ovary and testes clearly influence development.[2] That the secretions of various glands affect human development has been shown by a variety of observations. "Thus an injury to the pituitary body, which lies beneath the vertebrate brain, results in stunted stature, marked adiposity, and delayed or imperfect sexual development; on the other hand, a diseased condition of the pituitary body, rousing it to excessive function, is followed by a great increase in the general size of the head, as well as by a complete change in the proportions of the face from broad to long and narrow, and an abnormal growth of the long limb-bones, while at the same time the proportions of the hands are changed from normal to the short and broad condition known as brachydactyly." [3] This influence of the secretions extends to the nervous system and mental characters as well, if we accept the views of such writers as Abraham Myerson.[4]

[1] Conklin, *Heredity and Environment*, p. 326. [2] *Ibid.*, pp. 330–331.

[3] Osborn, *The Origin and Evolution of Life*, 1916, p. 75. Cf. pp. 74–79 (summarized from Harvey Cushing's *The Pituitary Body and its Disorders*, 1912, and Sir Edward Schaefer's *The Endocrine Organs*, 1916).

[4] Myerson, *The Foundations of Personality*, 1921, pp. 11–17.

Nägeli says that Alpine plants, "which have preserved the characters of high mountain plants since the ice age, lose these characters perfectly during their first summer in the lowlands." [1]

In considering the reactions of organisms, we mentioned Loeb's experiment on *Tubularia*, where a new head is generated at either free end of a section if the other end is buried in sand, but when both ends are buried no head is produced. "This proves in the clearest manner that in this case the power to form a definite complicated structure is called forth by the stimulus of the external environment." [2]

All these observations clearly show the marked influence of environment. They point, however, to a view that the environment calls forth an inherited power of the germ rather than that the environment immediately determines the result. The facts of adaptation bear on this general subject.

How does it come about that birds are fitted to the air, fish to the water, and animals to the land? So far as individuals are concerned, if acquired characters are not transmitted there is little meaning to adaptation, for it means only that the environment causes certain changes. But individuals do show a power of changing. Thus *Artemia salina* is a salt-water species which becomes *Branchipus stagnalis* in fresh water.[3]

mental stimuli, and although heredity is a relatively constant factor while environment is a more variable one, nevertheless the two are indispensable to development." [1]

In all these cases of adaptation and individual development it is clear that there is a mixture of the hereditary and the environmental elements. But it is not clear what is the relative importance of these two elements; and, in view of the doubt as to the inheritance of acquired characters, it is a serious question whether adaptations acquired by the individual are transmitted to the offspring. Let us now turn to the influence of environment on the development of man.

We have seen that man inherits biologically in the same manner as the lower forms. We have also seen that environmental agencies markedly influence his development, especially such agencies as are brought about by the internal secretions of the glands. There is, however, a vastly more important aspect of the influence of environment on man's development. This aspect of environmental influence we have referred to as man's social heritage. Space lacks for a detailed examination of this intricate problem; but it is necessary at least to indicate its importance, for without it the biological picture of man is incomplete. No doubt the same kind of general laws apply to man as to the lower organisms. Yet man has a very special relation to environment. His social environment, — the nation, municipality, and home of which he is a part, the religious and moral beliefs with which he is surrounded, the education, culture, clubs, and social groups to which he belongs, — all these are aspects of the environment which are transmitted to the individual through tradition and have been called our social heritage. This social environment is of the very greatest importance to man. So Mr. Graham Wallas asserts: "If the earth were struck by one of Mr. Wells's comets, and if, in consequence,

[1] Conklin, *Heredity and Environment*, p. 300.

every human being now alive were to lose all the knowledge and habits which he had acquired from preceding generations (though retaining unchanged all his own powers of invention, and memory and habituation) nine tenths of the inhabitants of London or New York would be dead in a month, and 99 per cent of the remaining tenth would be dead in six months." [1] Therefore it would seem at first sight as if the biological hereditary factors were of minor importance in the development of man, and the social heritage, the environment, of extreme importance.

Dr. William McDougall has pointed out that this view was held by J. S. Mill and is inherent in American ideas of education and government.[2] He also shows that the general effects of environment on human development and history are emphasized by T. H. Buckle, M. J. Finot, J. M. Robertson, and J. Oakesmith.[3] Opposed to the view that human development depends on environment are Count Gobineau, Dr. C. Woodruff, Madison Grant, and De Lapouge,[4] to whom may be added Dr. William McDougall and Dr. Raymond Pearl.

The issue has been excellently stated by Dr. McDougall: "Let us imagine that in some one of the great well-defined nations — say the British — every infant, throughout a period of fifty years, could be exchanged without the knowledge of its parents for an infant of another people. If this were done, at the close of the period of fifty years the anthropologic constitution of the nation would have been completely changed or exchanged. Would that affect the future course of its national life? If so, in what manner and degree? If we suppose the exchange to have been made with some other nation of similar composition and level of culture, the race-slumpers — Messrs.

[1] Wallas, *Our Social Heritage*, 1921, p. 16. (By courtesy of the Yale University Press, New Haven.)

[2] McDougall, *Is America Safe for Democracy?* 1921, pp. 20–24.

[3] *Ibid*., pp. 25, 29–31.

[4] *Ibid*., pp. 25, 28–29.

Finot, Oakesmith, Robertson — would confidently reply: 'No, it would make no difference.' Would they give the same reply if the exchange were made with some remoter people, say the Japanese, or Armenians, or Italians; or with a still remoter people, say the Hottentots or the Bushmen of southern Africa, or the Malays of the Far East?"[1] To this question Dr. McDougall makes the answer that such an exchange would make a very great difference, because civilization depends on innate differences of races, as is shown by comparative studies with mental tests and in a variety of other ways. The traits that are biologically inherited are what determine human development.[2]

Dr. Raymond Pearl, in his *Biology of Death*, reaches a similar conclusion in respect to one character of human development, longevity: "So the third large result is that heredity is the primary and fundamental determiner of the length of the span of life," and probably "environmental circumstances play their part in determining the duration of life largely, if not in principle entirely, by influencing the *rate* at which the vital patrimony is spent."[3] And all this, of course, in spite of such social environment as is furnished by preventive medicine and by public-health service.

That there is marked disagreement with this view of the relative value of heredity and environment as exhibited in man's social environment is well shown by the following quotations from Conklin:

"In his inspiring address on 'The Energies of Men' William James showed that we have reservoirs of power which we rarely tap, great energies upon which we seldom draw, and that we habitually live upon a level which is far below that which we might occupy. . . .

[1] McDougall, *Is America Safe for Democracy?* p. 31. (By courtesy of Charles Scribner's Sons, New York.)

[2] *Ibid.*, pp. 115-147.

[3] Pearl, *The Biology of Death*, 1922, pp. 225-226.

"We form the habit of thinking of great men as having appeared only at long intervals, and yet we know that great crises always discover great men. What does this mean but that the men are ready formed and that it requires only this extra stimulus to call them forth? To most of us heredity has been kind — kinder than we know. The possibilities within us are great but they rarely come to full epiphany.

"What is needed in education more than anything else is some means or system which will train the powers of self discovery and self control." [1]

"But it will be said that self control depends upon inheritance, that strong wills and weak wills are such because of heredity. It is true that one man may be born with a potentiality for self control which another man lacks, but in all men this potentiality becomes actuality only through development, one of the principal factors of which is use or functional activity. An amazing number of persons have but little self control. Is this always due to defective inheritance, or is it not frequently the result of bad habits, of arrested development? To charge defects at once to heredity removes them from any possible control, helps to make men irresponsible, excuses them for making the least of their endowments. To hold that everything has been predetermined, that nothing is self determined, that all our traits and acts are fixed beyond the possibility of change is an enervating philosophy and is not good science, for it does not accord with the evidence." [2]

"Whether all the phenomena of life and of mind can be explained on the basis of a purely mechanistic hypothesis or not, that hypothesis must square with the facts and not the facts with the hypothesis.[3]

"Because we can find no place in our philosophy and logic for

[1] Conklin, *Heredity and Environment*, pp 472, 474–475.
[2] *Ibid*, pp. 477–478. Cf L. T. Hobhouse, *Development and Purpose*
[3] Conklin, *Heredity and Environment*, p. 479.

self determination shall we cease to be scientists and close our eyes to the evidence? The first duty of science is to appeal to fact and to settle later with logic and philosophy. Is it not a fact that the possibilities of our inheritance depend for their realization upon development, one of the most important factors of which is use, functional activity in response to stimuli? Is it not a fact that in many animals behavior is modifiable and that impulses may be inhibited and controlled? Is it not a fact that experience, intelligence, will are factors in human behavior and that by means of these men are often able to choose between alternatives and so to control their own activities as well as external phenomena? Is it not a fact that our capacities are very much greater than our habitual demands upon them? Is it not a fact that belief in our responsibility energizes our lives and gives vigor to our mental and moral fiber? Is it not a fact that shifting all responsibility from men to their heredity or to that part of their environment which is beyond their control helps to make them irresponsible?"[1]

"The decay of the most gifted races of the ancient world, especially those of Greece and Rome, was not due primarily to bad heredity nor to bad material environment but rather to the growth of luxury and selfishness and unrestricted freedom."[2]

Here we have two very eminent scientists who seem to arrive at conclusions that are diametrically opposed.

Professor Taussig, in a masterly lecture, calls attention to the fact that it is an undecided question whether social stratification is due to innate qualities or to environment. He presents at some length the results of Mr. Havelock Ellis's investigation of British men of genius[3] who had apparently acquired their distinguished positions through no obvious inherited privileges. Mr. Ellis found that the upper classes in England contributed

[1] Conklin, *Heredity and Environment*, pp. 479–480.
[2] *Ibid.*, p. 485.
[3] *A Study of British Genius*, 1904.

18½% to these distinguished individuals, although the upper classes are only ⅕ of 1% of the total population. A second group, which included the law, army, navy, and professional classes, constituting 4½% of the total population, contributed 45% of the distinguished persons. The commercial and industrial classes, 21% of the population, contributed only 19%. Manual laborers, yeomen, farmers, and other such classes, 75% of the population, contributed 18%. Mr. Ellis says the conclusion is obvious: innate ability is much more widely distributed among the upper classes; social stratification rests on superiority, not on privilege.

Professor Odin[1] made a similar research on men of letters in Bulgaria, including about six thousand individuals. He found that the nobility, about 1% of the population, contributed 25% of the men of talent and 30% of the men of genius. The liberal professions, 6% of the population, contributed 23% of the men of talent and 24% of the men of genius. The manual laborers, 80% of the population, contributed only 10% of the men of talent and genius. M. Odin explains these results, which well agree with those of Mr. Ellis, in a wholly different way. He holds that it is opportunity which determines the result. For apply another test: what proportion of these men were born in the city and what in the country? An immensely large proportion of the distinguished men were born in the city, where greater opportunity is given. But in answer to this it may be said that those of more innate ability naturally go to the city; hence the superiority of the men in the city is due not to environment but to heredity. The statistical evidence may be interpreted in either way.

The testimony of biology Professor Taussig holds to be inconclusive, a conclusion with which all must agree. Psychology also contributes to the discussion. Intelligence tests show a better

[1] Alfred Odin, *Genèse des grands hommes*. Paris, 1895.

score for the children of the well-to-do than for the children of manual laborers. This is held to prove that there are innate differences. "Here again the evidence seems to me inconclusive. It is not certain that the effects of training and environment have been adequately eliminated. The technique of the method has hardly been so far perfected as to conform to this indispensable requirement. . . . We must admit, therefore, that the problem is not solved. We can lay down no certain conclusion. None the less, I cannot but believe that the trend of evidence is in the direction of the doctrine of superiority. That view has more support from the statistical and psychological evidence, more consonance with the implications of biology, than its rival." So we must suppose that individuals are born with innate differences in ability, that no men are free *and equal*. This conclusion of course does not mean that environment plays no part, that education and endeavor are not necessary; on the contrary, they are essential in bringing out the innate qualities. "Each of us has potentialities, not capacities."[1]

The question of the influence of environment on human development is thus interpreted differently by different authorities. It is such a vitally important subject that we must examine the evidence somewhat further. It really reduces to the question whether the race can be improved permanently by processes of education or whether the only possibility for permanent improvement lies in rational breeding, in eugenics. So we find Mr. Herbert saying: "We thus arrive at our final conclusion that the only means of permanently raising the standard of the race consists in the conscious and deliberate application of the method of rational selection — *i.e.*, selective breeding, or, as it has been aptly named by Galton, 'Eugenics.'"[2] But the same opposition

[1] F. W. Taussig, "Social Classes and Social Duties," in *Harvard Alumni Bulletin*, xxv, 772-778 (No. 26, March 29, 1923). Quoted by courtesy of the editors of the *Bulletin*.

[2] S. Herbert, *The First Principles of Heredity*, 1910, p. 181. Cf. McDougall, *Is America Safe for Democracy?*

is to be noticed here; for Dr. Conklin, while recognizing fully the importance of genetics, concludes his examination in these words: "The possible improvements of heredity are great, the possible improvements of environment and training are great, but whether men of the future will be better than those of the past or present is a question not only of genetics but also of ethics." [1]

There is, then, apparently no unanimity as to the relative value of heredity and environment, no matter from what point of view we approach the subject. It will be instructive to examine the case of man a little more closely. Although it is impossible to take strains of the human race and breed them under exact conditions, as is done with strains of *Œnothera*, yet nature has made such experiments, which have been observed. It is to a depressing side of human nature that most attention has been called, to cases in which the race has deteriorated, apparently through inherited detrimental characters. But there is no doubt that, if such detrimental characters are inherited, the valuable ones are too. According to the analogy of artificial breeding, it is largely by the removal of harmful heritable characters that progress in the betterment of the human stock can be brought about.

Let us consider the experiments, if such they may be called. These experiments consist in investigating the history of certain families, in the attempt to prove that combinations of definite hereditary traits lead to a marked degeneration in the stock; thus they tend to show that what determines the development of character is due very largely, if not wholly, to heredity, environment being a negligible element.

"A farmer lived twenty miles distant from his nearest neighbor, whose only child he married. . . . He then found lead on his farm and went to a city . . . where he made money more as

[1] Conklin, *Heredity and Environment*, pp. 490–491.

a cunning tool than an adventurer. He became a high liver, gouty and dyspeptic, and died with symptoms of gouty kidney at 70. The couple had five children. The eldest, a son, became a 'Napoleon of Finance.' . . . He married a society woman, the last scion of an old family. The second child, a daughter, was club-footed and early suffered from gouty tophi. She married a society man of old family who had cleft palate. The third child, a daughter, had congenital squint. She married a man who suffered from migraine of a periodical type. The fourth child, a daughter, was normal. She married a thirty-year-old active business man, in whom ataxia developed a year after marriage. The fifth child, a son, was ataxic at eighteen. The children of the 'Napoleon of Finance' and the society woman were an imbecile son, a nymphomaniac, a hysteric, a female epileptic who had a double uterus, and a son who wrote verses and was a society man. The cleft-palated society man and club-footed woman had triplets born dead and a squinting, migrainous son, who, left penniless by his parents, married his cousin, the nymphomaniac daughter of the 'Napoleon of Finance,' after being detected in an intrigue with her. The migrainous man and squinting daughter of the farmer stock-broker had a sexually inverted masculine daughter, a daughter subject to periodical bleeding at the nose irrespective of menstruation, as well as chorea during childhood, a normal daughter, a deaf-mute phthisical son, a daughter with cloacal formation of the perineum, an ameliac son, a cyclopean daughter (with one central eye) born dead, and, finally, a normal son. The sexual invert married the versifier son of the 'Napoleon of Finance.' The progeny of the normal daughter of the farmer stock-broker and the ataxic husband were a dead-born, sarcomatous son, a gouty son, twin boys paralyzed in infancy, twin girls normal, a normal son, and a son ataxic at fourteen. The progeny of the nymphomaniac daughter and her strabismic, migrainous cousin

were a ne'er-do-well, a periodical lunatic, a dipsomaniac daughter who died of cancer of the stomach, deformed triplets who died at birth, an epileptic imbecile son, a hermaphrodite, a prostitute, a double monster born dead, a normal daughter and a paranoiac son." [1]

Let us take another example: "A typical case is that of the 'Juke Family,' which was first investigated in the year 1877, and reinvestigated in 1915. To quote from the original study: 'From one lazy vagabond nicknamed "Juke," born in rural New York in 1720, whose two sons married five degenerate sisters, six generations numbering about 1,200 persons of every grade of idleness, viciousness, lewdness, pauperism, disease, idiocy, insanity, and criminality were traced. Of the total seven generations, 300 died in infancy; 310 were professional paupers, kept in almshouses a total of 2,300 years; 440 were physically wrecked by their own "diseased wickedness"; more than half the women fell into prostitution; 130 were convicted criminals; 60 were thieves; 7 were murderers; only 20 learned a trade, 10 of these in state prison, and all at a state cost of over $1,250,000.' By the year 1915, the clan had reached its ninth generation, and had greatly lengthened its evil record. It then numbered 2,820 individuals, half of whom were alive. About the year 1880 the Jukes had left their original home and had scattered widely over the country, but change of environment had made no material change in their natures, for they still showed 'the same feeble-mindedness, indolence, licentiousness, and dishonesty, even when not handicapped by the associations of their bad family name and despite the fact of their being surrounded by better social conditions.' The cost to the state had now risen to about $2,500,000. As the investigator remarks, all this evil

[1] Samuel J. Holmes, *The Trend of the Race*, 1921, pp. 67–68 ("reported by Kiernan and described in Talbot's *Degeneracy*"; reprinted here, as are other quotations, by courtesy of Messrs. Harcourt, Brace, and Company, Inc., New York).

might have been averted by preventing the reproduction of the first Jukes. As it is, the Jukes problem is still with us in growing severity, for in 1915, 'out of approximately 600 living feeble-minded and epileptic Jukes, there are only three now in custodial care.'"[1]

One more example: "A striking illustration of how superiority and degeneracy are alike rigidly determined by heredity is afforded by the 'Kallikak Family,' of New Jersey. During the Revolutionary War, one Martin 'Kallikak,' a young soldier of good stock, had an illicit affair with a feeble-minded servant-girl, by whom he had a son. Some years later, Martin married a woman of good family by whom he had several legitimate children. Now this is what happened: Martin's legitimate children by the woman of good stock all turned out well and founded one of the most distinguished families in New Jersey. 'In this family and its collateral branches we find nothing but good representative citizenship. There are doctors, lawyers, judges, educators, traders, landholders, in short, respectable citizens, men and women prominent in every phase of social life. They have scattered over the United States and are prominent in their communities wherever they have gone. . . . There have been no feeble-minded among them; no illegitimate children; no immoral women; only one man was sexually loose.' In sharp contrast to this branch of the family stand the descendants of the feeble-minded girl. Of these 480 have been traced. Their record is: 143 clearly feeble-minded, 36 illegitimate, 33 grossly immoral (mostly prostitutes), 24 confirmed alcoholics, 3 epileptics, 82 died in infancy, 3 criminals, 8 kept houses of ill fame. Here are two family lines, with the same paternal ancestor, living on the same soil, in the same atmosphere, and under the same general

[1] Lothrop Stoddard, *The Revolt against Civilization*, 1922, pp. 95–96. Stoddard quotes from pages cited in Popenoe and Johnson's *Applied Eugenics*, 1920, pp. 159–160. (This quotation and the following one are by courtesy of Charles Scribner's Sons, New York.)

environment; 'yet the bar sinister has marked every generation of one and has been unknown in the other.'" [1]

Writers like Dr. Lothrop Stoddard are overwhelmed by the influence of heredity and the dangers that may result to society unless public control of the propagation of such families is exercised. In general it seems that Dr. McDougall would agree,[2] and Professor Parker has often expressed himself as in favor of such control.[3] When to these awful genealogies are added the conclusions reached by statistical researches on the decline of the birth-rate as formulated by Dr. Holmes, the outlook becomes appalling; for there is very little doubt that families of the type of the Jukes and the Kallikaks, and types intermediate between them and the better classes, increase much more rapidly than the kind of family that society must wish to preserve.[4] But there are other writers who view the matter more hopefully.

Dr. Henry A. Cotton, while not denying that constitutional defects and general lack of stamina may be inherited, and while believing that the increase in insanity is out of all proportion to the increase in population, holds that the specific influence of heredity in mental and physical abnormalities has been much exaggerated, that many of these disturbances are due to circulating toxins caused by infections in various parts of the body and by disturbances in the secretions of the endocrine glands; hence that the most promising practical procedure for the control of insanity is to eliminate these bodily environmental conditions which are among the causes.[5] The Society for Mental Hygiene is founded on the theory that much insanity is a pre-

[1] Stoddard, *Revolt*, pp. 96–97. Stoddard quotes from Holmes's *Trend of the Race*, p 31, and from Popenoe and Johnson, p 160.

[2] McDougall, *Is America Safe for Democracy?* p 195

[3] G. H Parker, *Biology and Social Problems*, 1914

[4] Holmes, *The Trend of the Race*, ch. vii, "The Causes of the Declining Birth Rate."

[5] Cotton, *The Defective, Delinquent, and Insane*, 1921, pp 31–32

ventable disease and may be controlled by agencies similar to those recommended by Dr. Cotton, abetted by proper changes in the mental environment.

Commenting on such cases, Dr. Holmes says: "From the standpoint of heredity, such families as the Jukes, Ishmaelites, Zeroes, etc., constitute a complex problem. That bad environment and the evil influences of family traditions are potent factors in determining the degradation of these unfortunate people, there can be no doubt. But there can be little doubt that heredity is a factor of great potency as well. Criminality may be due, not so much to the transmission of vicious propensities (although there is evidence that vicious traits are transmitted), as to the inheritance of mental defect and general lack of stamina."[1]

What can we glean from such a mass of conflicting evidence and different interpretations? It would seem that both heredity and environment are important factors. If the development of the individual and of the race is to be bettered, then so far as we can see at present both biological inheritance and social and material environment should be controlled. Biological inheritance can be governed only by the segregation or the sterilization of the mentally unfit, or by a process of education whereby individuals of tainted inheritance will voluntarily refuse to propagate. In the case of the more manifestly unfit educational methods seem useless; and in view of the blindness and strength of the sex-impulse they seem well-nigh hopeless anywhere. Control by compulsion is, then, the only practical remedy in so far as biological inheritance is concerned; we must reach the conclusion that the manifestly unfit should be prevented from multiplying, either by segregation or by sterilization according to circumstances in individual cases. Such a procedure is especially necessary because the whole trend of modern civilization, by means of preventive medicine and social aids, is to

[1] Holmes, *The Trend of the Race*, p. 86.

suspend the action of the natural forces that tend to restrict the number of the manifestly unfit.

Of the importance and necessity for the control of environment perhaps nothing need be said; for all kinds of charitable and social and labor organizations, including churches and societies and the State, are at work on the specific ways of influencing development through environmental conditions. The whole lesson of biology seems to be that the environment calls out a response from what is latent in the germ. We must furnish the best possible environment.

The greatest theoretical hope for the improvement of the individual, and through the individual of society, would, then, lie in the control of both heredity and environmental conditions. All of which sounds very fine theoretically, but practically the difficulties of such a procedure seem well-nigh insurmountable, though a beginning has already been made in some States.[1] According to Dr. Holmes, "the Right Rev. Monsignor W. F. Brown in setting forth the attitude of the Church before the National Birth Rate Commission declared that the State cannot lawfully forbid the marriage of the physically defective or even the feeble-minded."[2] What his position in regard to sterilization would be I do not know, nor do I know what the attitude of the Protestant churches would be.[3] Evidently, however, great practical difficulties are involved; but theoretically control of the germ-plasm of the more unfit seems a very necessary procedure. Dr. Holmes agrees that such measures "would undoubtedly relieve society of an immense burden. . . . The race has its fate in its own hands to make or to mar. Will it ever take itself in hand and shape its own destiny?"[4]

[1] H. L. Hollingworth and A. T. Poffenberger, *Applied Psychology*, new ed., 1923, pp. 51–53.

[2] Holmes, *The Trend of the Race*, p. 362.

[3] Possibly a hint is given by the Rev. Leonard Hodgson, "Birth-Control and Christian Ethics," in the *Hibbert Journal*, October, 1923, xxii, 64–74.

[4] Holmes, *The Trend of the Race*, pp. 381, 383.

Dr. McDougall has recently pointed out with great skill the inadequacy of current ethical theory to cope with the problem of population and with other political and racial questions. He believes we must reject the principles that all men in a literal sense are equal and that the individual alone should be considered, but thinks we must treat men as a means for bringing about the highest happiness for the greatest number. This goal can be reached only through an enlightened nationalism broadened to include international coöperation. Enlightened nationalism involves a combination of the aristocratic and the democratic principles, and includes restriction of the birth-rate, especially of the less valuable elements of society.[1]

But, as Dr. E. M. East has shown, even if one objects on ethical grounds to a rational restriction of increase in population, such restriction is inevitable; for population tends, as Malthus asserted, to increase in a geometrical proportion but food-supply in an arithmetical one, and apparently increase in food-supply must eventually cease. With much support from facts, Dr. East points out that within one hundred years the increase in population must be radically restricted, and that civilization will relapse into barbarism unless a just balance between available food and number of inhabitants is maintained. The rational conclusion is to face the facts, to control population consciously so as to prevent the increase of undesirable strains, and to begin *now*.[2] There seems little doubt that Dr. East is right.

But, lest I be understood to mean that I believe the sole means for social improvement are to be found in genetics, let me call attention to what I think are two great experiments on the influence of social environment, through education, upon the development of the individual. One is furnished by the Roman Catholic Church, which through a great organization embodying immense practical wisdom succeeds in impressing its views on an exceedingly large number of individuals. The other is, or was, the German Empire, which likewise through an immense organization of its educational system succeeded in imposing a certain theory of conduct on a very large number of its citizens. These experiments, if such they may be called, exhibit two points in common: a great organization with a definite plan of action; a theory that to accomplish results in moulding the development of individuals it is necessary to train individuals continuously from birth to maturity. Society can learn a lesson from these examples. If it wishes by education to improve social conditions, it must conform to three requirements. (1) It must attain some plan of action, some ideal for which to strive. Such an ideal may be changed and enlarged, but some concrete aim is necessary. (2) In order to control development according to its ideal, society must seize its material early. (3) The only agency by which it can do this on a large scale is through the public schools.

May I suggest how society could conceivably apply an ideal for the development of the individual through its schools? In Massachusetts, I am told, it is a rule in the public schools that before classes begin in the morning the teachers shall read short selections from the Bible; it is also a rule that no comment shall be made on the moral or religious significance of such selections. In conversation with some of my teacher-friends I have been informed that many public-school teachers would welcome a

code of ethical or moral teaching that would furnish them with an outline of permissible comments to be made on the text; that they are ready and eager to give moral instruction throughout their class work. Theoretically I believe that in some such way society must furnish moral education to its citizens, but practically, again, the difficulties seem insurmountable. I am, however, thoroughly convinced that without such moral instruction education defeats its own object; that it merely furnishes tools for good and evil alike to use as they see fit; that in the case of the evil mind society is through education merely furnishing tools to be used against itself.

But what is the result of this long examination of heredity, variation, and environment? The same that we have noted in other departments of science. Some general mechanistic account is furnished, incomplete, upon the details of which there is no agreement. Opposed to this is the opinion, held by not such a large number of scientists but nevertheless by a considerable body of men of good repute, that no explanation of heredity and variation can be given in mechanistic terms. Then there is the third view, held by perhaps the most eminent and conservative scientists, that, although a beginning has been made, yet the explanation of these difficult subjects still rests in obscurity. As to the relation of heredity and environment, and as to the problem of acquired characters, we find like divergencies of opinion; the general view in regard to acquired characters is that there is no evidence that such characters are transmitted. As regards the evolution of man, there seems in general a pretty universal tendency to hold that his conduct is a response of hereditary tendencies to environmental conditions and that both factors must be taken into account.[1] The implications derived from a study of heredity for a theory of character are obvious.

[1] Cf. Vernon L. Kellogg, *Mind and Heredity*, 1923.

When, therefore, we contemplate a return to our task of formulating a theory of organic evolution based on such lack of agreement and on such ignorance, we may reasonably be filled with despair. Let us, however, briefly review what solutions of the problem have been offered.

CHAPTER XX

THEORIES OF EVOLUTION

HOWEVER imperfect our knowledge of heredity and variation, the fact remains that there is descent. Many theories have been formed in the attempt to render this fact of the gradual transformation of species intelligible. There are certain general and crucial facts that all theories must face, some of them of a very general nature, some more concrete. (1) There is the demand for uniformity in explanation, usually but unnecessarily stated in the form that everything shall be explained in terms of natural law without the introduction of any such concept as teleology. (2) The fact that evolution does not display a consistent movement towards a definite end, but exhibits returns and branchings into blind alleys and a persistence of early forms in conjunction with more developed ones. (3) The general facts of heredity, especially the lack of evidence for the inheritance of acquired characters. (4) The fact of variation, — that some are useful and some are not, that some show very remarkable adaptations to local and climatic conditions, that we have no knowledge of the cause of variation. (5) The facts of regeneration and individual development, and (6) those of mental phenomena. From our survey it is evident that no very satisfactory result will be obtained; but let us examine briefly the main aspects of some of these theories of descent, no one of which has been universally accepted.

First let us take the Lamarckian theory. All varieties of this theory assume that the environment acts on the organism and that the organism reacts with more or less permanent results for itself. Thus, if the environment consists of trees, animals gradu-

ally begin to use their limbs in climbing; their limbs are modified by this use, and this acquired character is retained and passed on to the offspring. Also in some Lamarckian theories the environment is held to create a want. For example, an elephant with a short trunk happens to go to a country in which there are high trees; he wants the leaves; he keeps trying to reach them. This want caused by the environment is held to lead him to continual attempts to satisfy the want, and through repeated use these attempts are reflected in his organism and his trunk grows longer; this trait is retained in the organism and is transmitted through heredity. The environment can also act passively. One example is furnished by the influence of lack of food, which stunts growth; another by the action of light on the skin, whereby sensitive spots are produced which eventually, through natural selection and the heredity of these acquired sensitive spots, develop into eyes.

"Professor Henslow has accumulated in his two books, 'The Origin of Plant Structures,' and 'The Origin of Floral Structures,' a vast mass of facts about plant life, all tending to show that the structures of plants are due to the influence of external agencies. Thus the structure of the stem, the origin of spines, the shape of the leaves, the tendrils and pads of climbing plants, etc., can, according to him, all be accounted for by the reaction of the growing plant-organism to the incidence of surrounding forces. It is a well-known fact that plants change their character with their environment, according as they are reared in dry or moist climates, in high or low altitudes, etc. Flowers can similarly be explained by 'self-adaptation to insect-agency.' The nectar-seeking insects alighting on the flower produce various stresses and strains in the floral parts, whence result not only the different irregularities in the shape of the floral organs, of petals, sepals, etc., but also the secretive and hairy processes, the colour-markings, etc., of certain flowers. Even the nectaries

themselves are, according to this theory, to be ascribed to the nutritive currents in the plant tissues, set up in direct response to the irritation of the feeding insects.

"Coming from the realm of botany to that of zoology, we have the work of Professor Hyatt, who attributes the characteristics of molluscs and shells, as well as those of extant sponges, to the nature of the surrounding media. A. S. Packard upholds the Lamarckian factors as the sufficient cause of the metamorphosis of insects, of the peculiar tubercles, spines, and bristles of certain caterpillars, of the climatic variations of butterflies, etc. With regard to the higher animals, we have the studies of H. F. Osborn, who explains the structures of mammalian feet and teeth by the mechanical action of external agencies; while Professor Cope sees in 'friction, impaction and strain, brought about by use or motion,' the originating factors of the vertebral skeleton." [1]

While the facts of use and disuse of function as creating the organ — the changes resulting from the direct action of environment — are indisputable in some sense,[2] yet if these variations in the individual are to be summed up and preserved by the offspring so as to furnish a basis for the process of evolution, they must of course be inherited by the offspring. We have seen that there is little or no evidence that this occurs. All Lamarckian theories are thus open to suspicion. Psychologies and theories of societies, like Spencer's, built on such foundations have a very precarious footing.[3]

[1] S. Herbert, *The First Principles of Evolution*, 1913, pp. 115–116. (Quoted by courtesy of Messrs. A. and C. Black, Ltd., London.)

[2] Driesch, *The Science and Philosophy of the Organism*, 1907, p. 272.

[3] Herbert, *The First Principles of Evolution*, p. 178; Bergson, *L'évolution créatrice*, p. 85. For some account of Lamarckian theories, see A. S. Packard, *Lamarck, his Life and Work*, 1901; J. B. Lamarck, *Zoological Philosophy*, trans. Hugh Elliot, 1914; G. Henslow, *The Origin of Plant Structures*, 1895, and *The Origin of Floral Structures*, 1888; V. L. Kellogg, *Darwinism To-day*, 1907; E. D. Cope, *The Origin of the Fittest*, 1887, and *The Primary Factors of Organic Evolution*, 1896.

Recognition of this fact has led most students of evolution to adopt some form of the Darwinian explanation, which holds that existing organic forms are caused by natural selection acting on variations, which occur either by chance or as the result of the unknown laws of the development of the germ-plasm. Darwin, Wallace, Romanes, Weismann, T. H. Morgan, are examples of this school, but of course they interpret details differently. In so far as any of these theories — Romanes's, for example — rest even in part on the supposition that acquired characters are inherited, they are open to suspicion. But many of these Darwinian theories assume only such variations of the germ as are acted on by natural selection. This, for example, is Morgan's interpretation. But such a theory is sharply criticized by Bateson, Driesch, and Bergson, who hold that natural selection really explains nothing. Let us examine in a little more detail some of these theories and criticisms.

The Darwinian theory in its broadest sense, according to Driesch, maintains: "The offspring of a certain number of adults show differences compared with each other; there are more individuals in the offspring than can grow up under the given conditions, therefore there will be a struggle for existence amongst them which only the fittest will survive; these survivors may be said to have been 'selected' by natural means.

"It must be certain from the very beginning of analysis that natural selection, as defined here, can only eliminate what cannot survive, what cannot stand the environment in the broadest sense, but that natural selection never is able to create diversities. It always acts negatively only, never positively. And therefore it can 'explain' — if you will allow me to make use of this ambiguous word — it can 'explain' only why certain types of organic specifications, imaginable *a priori*, do *not* actually exist, but it never explains at all the existence of the specifications of animal and vegetable forms that are actually found. In

speaking of an 'explanation' of the origin of the living specific forms by natural selection one therefore confuses the sufficient reason for the non-existence of what there is not, with the sufficient reason for the existence of what there is. To say that a man has explained some organic character by natural selection is, in the words of Nägeli, the same as if some one who is asked the question, 'Why is this tree covered with these leaves,' were to answer, 'Because the gardener did not cut them away.' Of course that would explain why there are no more leaves than those actually there, but it never would account for the existence and nature of the existing leaves as such. Or do we understand in the least why there are white bears in the Polar Regions if we are told that bears of other colours could not survive?

"In denying any real explanatory value to the concept of natural selection I am far from denying the action of natural selection. On the contrary, natural selection, to some degree, is *self-evident;* at least as far as it simply states that what is incompatible with permanent existence cannot exist permanently, it being granted that the originating of organic individuals is not in itself a guarantee of permanency. Chemical compounds, indeed, which decompose very rapidly under the conditions existing at the time when they originated may also be said to have been eliminated by 'natural selection.' . . . Natural selection is a negative, an eliminating factor in transformism; its action is self-evident to a very large degree, for it simply states that things do not exist if their continuance under the given conditions is impossible." [1]

Bateson, if I understand him, would agree to this view of natural selection as consisting of little more than a permissive force.[2] He finds more concrete reasons for criticizing the Dar-

[1] Driesch, *The Science and Philosophy of the Organism*, 1907, pp 261-263. (By courtesy of Messrs. A. and C. Black, Ltd. London.)

[2] Bateson, *Problems of Genetics*, 1913, pp. 17, 20, 235, 218.

winian theory in the fact that it fails to account for so many cases of specific differences that are of no assignable use to the organism. If natural selection produces species by picking out those best fitted to survive, then the resulting species should on the whole be fitted to their environment, and the specific enduring characters should apparently be the ones that are the most useful. "The case has been put by Wallace in an extreme way: 'It is a necessary deduction from the theory of natural selection, that none of the definite facts of organic nature — no special organ, no characteristic form or marking, no peculiarities of instinct or of habit, no relations between species or between groups of species — can exist, but which must now be, or once have been, *useful* to the individuals or the races which possess them.'"[1] Romanes agrees that, if no other factors than natural selection of chance variations are to be included, the characteristics of species must be of use.[2] He denies the premise,[3] however, and includes as factors in evolution (1) climate, (2) food, (3) sexual selection, (4) isolation, (5) innate laws of growth.[4] Temperature and food-supply cause changes in individuals; but these changes are probably acquired characters and therefore, so far as we know, are not inherited.[5] Sexual selection is not now generally accepted;[6] it is difficult to apply to the lower organisms and presumably cannot apply to the evolution of plants.[7] The only factors left, then, that may perhaps aid in explaining evolution are what Romanes describes as isolation and the laws

[1] Herbert, *The First Principles of Evolution*, p. 181, quoting from G. J. Romanes (*Darwin and after Darwin*, 1895, ii, 180), who quotes from A. R. Wallace (*Contributions to the Theory of Natural Selection*, 1870, p. 47).

[2] Romanes, *Darwin and after Darwin*, ii, 183.

[3] *Ibid.*, pp. 184–199. [4] *Ibid.*, pp. 200–227.

[5] Bateson, *Problems of Genetics*, pp. 187–233; T. H. Morgan, *A Critique of the Theory of Evolution*, 1916, pp. 13–34, 147–163; R. S. Lull, *Organic Evolution*, 1920, p. 12.

[6] Lull, *Organic Evolution*, p. 13; Herbert, *The First Principles of Evolution*, pp. 168–169.

[7] Lull, *Organic Evolution*, pp. 121–127.

of growth of the germ. These two factors must account for descent. The one that is concerned with the development of the germ has been amplified by modern research far beyond anything that Romanes had in mind.[1] Therefore the theory of descent that rests on variation or mutation caused by the laws of the germ and guided by natural selection seems acceptable to many, especially to T. H. Morgan,[2] and to Bateson with reservations.[3] They agree, however, that there is no theory of the origin of variations.

Bateson, in his remarkable book *Problems of Genetics*, criticizes the whole theory of evolution. His general argument appears to be that, although specific diversity cannot be caused by natural selection, since this would imply that all characters are useful, yet, by introducing the factor of the innate power of development of the germ, variations may be caused which by Mendelian heredity can be accumulated, and by the combination of these variations other variations may arise. In this way many facts can be explained; but natural selection must be modified into a force that tolerates, one that allows everything possible to survive. Yet even after these corrections much is still inexplicable. Let us look at his reasons.

Lychnis diurna and *vespertina* are both diœcious perennials, with similar flowers. They have so much in common that they have been regarded as varieties of the same species. *Diurna*, however, has red flowers, more ovate leaves, dark seeds, capsule-teeth rolled back, shorter fruits; *vespertina* has white flowers, more lanceolate leaves, grey seeds, almost erect capsule-teeth, longer fruits. Sometimes these plants grow side by side; then we find some *diurna*, some *vespertina*, and a few hybrids. Neither *diurna* nor *vespertina* could develop from the other; the only

[1] For Romanes's views, see his *Darwin and after Darwin*, iii (1897), 101–143; and ii (1895), 223–247.

[2] Morgan, *A Critique of the Theory of Evolution*, p. 194.

[3] Bateson, *Problems of Genetics*, p. 99.

possible supposition is that they came from a common parent.[1] "Why, if the common parent was strong enough to live to give rise to these two species, is it either altogether lost now, or at least absent from the whole of Northern Europe?" [2] There is no answer.

Now, on the Norfolk coast there is a locality where *vespertina* thrives, and not a hundred yards inland *diurna* thrives. But where *vespertina* thrives *diurna* is absent: *diurna* is here at a disadvantage and natural selection works. There is no connection that we can point out between the character of *vespertina* and the fact that it is better suited to a certain place. Thousands of examples of this sort are available. "In view of such facts as I have related and might indefinitely multiply, the fixity of specific characters cannot readily be held to be a measure of their economic importance to their possessors." [3] Characters of no assignable use persist and are fixed enough to form specific differences; and the theory of natural selection, which was formed to account for specific differences, fails to do so.

Moreover, if natural selection acting on chance variations were the cause of specific differences, we should expect that where conditions are the same forms would be similar. The studies of A. G. Mayer on *Partula otaheitana* are interesting in this connection. "The island of Tahiti has been scored by erosion so that a series of separated valleys radiate to the coast. From four successive valleys Mayer collected the species, and found that in the first (Tipaerui) valley all the shells were dextral (115, containing 73 young); in the second valley (Fautaua) 54 per cent. of adults and 55.5 per cent. of the young contained were sinistral; in the third valley (Hamuta) 69 per cent. of adults and 73 per cent. of young contained in them were sinistral; and lastly, in the fourth valley (Pirae) all the shells (131, containing 62 young) were sinistral. In connection with these

[1] Bateson, *Problems of Genetics*, pp. 18-23. [2] *Ibid.*, p. 19. [3] *Ibid.*, p. 21.

observations I may mention the fact that in a certain pond in the North of England the sinistral form of *Limnaea peregra* has been known to occur for about fifty years. Visiting it lately I found the left-handed shells to be about 3 per cent. of the population. The species is the commonest British fresh-water shell, but left-handed specimens are exceedingly rare. Will any one ask us to suppose that the persistence of a percentage of this rarity in the same place is an indication of some specially favouring circumstance in the waters of that pond? It is a horse-pond to all appearances exactly like any other horse-pond; and I believe that in perfect confidence we may accept the suggestion of common sense, which teaches us that there is nothing particular in the circumstances which either calls such varieties into existence or contributes in any direct way to their survival. . . . It is open to any one to suggest speculatively that the persistence of special varieties or of special variability in special places is an indication that in those places the conditions of life are such that the forms in question are tolerated though elsewhere the same types are exterminated; but that consideration, even if it could be proved to be well founded, is not one which lends much force to the thesis that definiteness of type is a consequence of Natural Selection. On the contrary, recourse to such reasoning implies the inevitable but very damaging admission that the stringency of Selection is frequently so far relaxed that two or more equally definite forms of the same species can persist side by side. There is no doubt that this is the simple truth, but when once that truth is perceived it is useless to invoke the control of Selection as the factor to which definiteness of type in general must be referred."[1]

Many of these variations may conceivably be understood as having arisen from recombinations of factors brought together

[1] Bateson, *Problems of Genetics*, pp. 183–184. (By courtesy of the Yale University Press, New Haven.)

by the crossing of parent species, one or both of which must be supposed to be lost. Evolution would then occur by a process of the unfolding or development of the germ, giving rise to variations; combinations of these variations would give rise to new ones; natural selection would act on these variations as a permissive and perhaps regulative but not as a determining cause. This is similar to the view of T. H. Morgan. Such a theory, however, does not account for all the facts. We fail to see why parents have been lost in so many instances. There is no proof that original large mutations are common. No clear account of original variations is given, and the most characteristic mark of species, interspecific sterility, remains a mystery. Such a theory, avoiding the controversy about the inheritance of acquired characters, accounts in a measure for the persistence of useless characters and for the differences in geographical distribution, and explains how different varieties can exist side by side in similar environment. By implicitly assuming some kind of force or power inherent in the germ which works against obstacles, it makes intelligible the various branchings and wanderings and windings and returnings that characterize the course of organic evolution. By accepting without proof the relatively large variations which through Mendelian heredity are preserved, it avoids the difficulty caused by the apparent impossibility of sorting out small accidental variations through natural selection.

But, with all that may be said in its favor, such a theory is still somewhat unsatisfactory. "The unpacking of an original complex, the loss of various elements, and the recombination of pre-existing materials may all be invoked as sources of specific diversity. Undoubtedly the range of possibilities thus opened up is large. It will even cover an immense number of actual examples which in practice pass as illustrations of specific distinction. . . .

"But will such analysis cover all or even most of the ordinary cases of specific diversity between near allies? Postponing the problem of the interrelations of the larger divisions as altogether beyond present comprehension, can we suppose that, in general, closely allied species and varieties represent the various consequences of the presence or absence of allelomorphic factors in their several combinations? The difficulty in making a positive answer lies in the fact that in most of the examples in which it has been possible to institute breeding experiments with a view to testing the question, a greater or less sterility is encountered. Where, however, no such sterility is met with, as for instance in the crosses made by E. Baur among the species of *Antirrhinum* there is every reason to think that the whole mass of differences can and will eventually be expressed in terms of ordinary Mendelian factors. Baur has for example crossed species so unlike as *Antirrhinum majus* and *molle,* forms differing from each other in almost every feature of organisation. The F_2 generation from this cross presents an amazingly motley array of types which might easily if met with in nature be described as many distinct species. Yet all are fertile and there is not the slightest difficulty in believing that they can all be reduced to terms of factorial analysis.

"If allowance be made for the complicating effects of sterility, is there anything which prevents us from supposing that such good species as those of *Veronica* or of any other genus comprising well-defined forms may not be similarly related? I do not know any reason which can be pointed to as finally excluding such a possibility." [1] But this does not dispose of all our difficulties; for "we have not even an inkling of the steps by which a Silver Wyandotte fowl descended from *Gallus Bankiva,* and we can scarcely even believe that it did. The Wyandotte has its enormous size, its rose comb, its silver lacing, its tame spirit, and

[1] Bateson, *Problems of Genetics,* pp. 98–99.

its high egg production. The tameness and the high egg production are probably enough both recessives, and though we cannot guess how the corresponding dominant factors have got lost, it is not very difficult to imagine that they were lost somehow. But the rose comb and the silver colour are *dominants*. The heavy weight also appears in the crosses with Leghorns, but we need not at once conclude that it depends on a simple dominant factor, because the big size of the crosses may be a consequence of the cross and may depend on other elements.

"Now no wild fowl known to us has these qualities. May we suppose that some extinct wild species had them? If so, may we again make the same supposition in all similar cases? To do so is little gain, for we are left with the further problem, whence did those lost wild species acquire those dominants? Suppositions of this kind help no more than did the once famous conjecture as to the origin of living things — that perhaps they came to earth on a meteorite." [1]

So, if you push the question back to the amœba, you must ask, What made the amœba acquire a new character, dominant if you like, which caused it to change and thus furnished a beginning for its further evolution? If we should wish to make a guess as to what the facts might indicate, we should, according to Bateson as I understand him, get a theory something like this: The germ has innate powers of change which it is continually exerting; this gives rise to a process that can only be described as the gradual elimination of inhibitive factors; the elimination of an inhibitive factor is a variation and is preserved by Mendelian heredity. Evolution might, then, consist in the progressive dropping out of inhibitive factors, in the unpacking of an original complex. On these variations and their combinations natural selection exerts a guiding influence.[2] In this way, per-

[1] Bateson, *Problems of Genetics*, pp. 97–98.
[2] *Ibid.*, p. 96; Morgan, *A Critique of the Theory of Evolution*, p. 86.

haps, the general progressive movement described as the transformation of the species could be understood; but the origin of mutations would still be a mystery, especially such variations as interspecific sterility.[1]

T. H. Morgan considers this theory of Bateson so fantastic that he refuses to believe that Bateson really takes it seriously.[2] But J. Arthur Thomson treats it with more respect. "Professor Bateson is one of the foremost living ætiologists, and respect is due to his pronouncement that we must begin seriously to consider 'whether the course of Evolution can at all reasonably be represented as an unpacking of an original complex, which contained within itself the whole range of diversity which living things present. . . . As we have got to recognise that there has been an Evolution, that somehow or other the forms of life have arisen from fewer forms, we may as well see whether we are limited to the old view that evolutionary progress is from the simple to the complex, and whether after all it is conceivable that the process was the other way about. . . . At first it may seem rank absurdity to suppose that the primordial form or forms of protoplasm could have contained complexity enough to produce the divers types of life. But is it easier to imagine that these powers could have been conveyed by extrinsic additions?'. . .

"We are unwilling, however, to accept Professor Bateson's picture as a complete one, and that for several reasons. (1) The first is that it makes the origin and nature of the primordial organisms too utterly miraculous if we suppose them to have had such a rich stock of initiatives and implications. (2) It seems to lead to a very mechanical picture of evolution, as if it were just an age-long unrolling of a stupendous gramophone

[1] See Bateson, *Problems of Genetics*, p. 249; and his "Inaugural Address" at Sydney, Australia, 1914, in *Nature*, xciii, 674 ff. See also J. A. Thomson, *The System of Animate Nature*, 1920, ii, 362–367.

[2] Morgan, *A Critique of the Theory of Evolution*, p. 36.

record. . . . (3) Given an artistic genius, we may assert that all that he did in the last forty years of his life was in him when he was twenty-one. But is this necessarily an accurate statement? His achievements at thirty are the product of his hereditary nature, admittedly well-expressed at his coming of age, but also of what he has made of his life and his chances, and of what society has made of him. The organism works on a compound interest principle; especially in its mental aspect it is made as well as born. And what is true of an explicit individual that he makes experiments in self-expression may be true for aught we know of those implicit, telescoped-down individualities which we call germ-cells. In any case, we see no reason to part with the idea of the full-grown organism as an agent that shares in its own evolution.

"In so far as Professor Bateson's view is just a paradoxical way of saying that there is nothing evolved which was not, in kind, originally involved; that there is nothing of lasting value in the end which was not present, in kind, in the beginning, we have no fault to find with it, provided it be clearly recognised that it necessitates the assumption that the ancestral creatures had the primordia of mental as well as of bodily organisation." . . .

"But if Mr. Bateson's view implies that the apparent origin of the new is illusory, that creative evolution is a fiction, that evolution means unfolding (evolutio) not new-formation (epigenesis), it does not seem to us to be in accordance with the facts.

"In the study of individual development embryologists have to do with the emergence of the obviously complex from the apparently simple. We mean by apparently simple that the egg has no organs or tissues or the like, but all the modern work on germ-cells points to the conclusion that for each distinct feature in the adult there is in the germ-cell a *something* which

divides and persists. Thus arises what Prof. E. B. Wilson calls the puzzle of the microcosm: 'Is the hen's egg fundamentally as complex as the hen, and is development merely the transformation of one kind of complexity into another?' . . .

"What biology seems justified in holding firm to is, that there has been a frequent epigenesis or new formation, a frequent outcrop of genuine novelties. Without insisting on the epigenetic character of the emergence of feeling and other forms of consciousness, we mean, in concrete language, that there was a time when there were no insects; they came into being, and they were new ideas. There was a time when there were no birds; they came into being, and they were new ideas. It may be very naïve on the biologist's part, but it does not appear likely that any argument that being is a fixed quantity will affect his belief that insects and birds were downright novelties. Evolution is racial epigenesis — the making actual of what was only potential; but it is more, it is a series of great inventions, — in a way, a succession of new worlds." [1]

This theory of Bateson's is to me extremely interesting. In the form in which he puts it, it is, as Thomson well says, very largely a mechanical description. But suppose you translate it into mental terms. For Bateson, evolution is the overcoming of impediments; in mental terms this might be stated as the overcoming of ignorance by a process of trial and error. Evolution would then be the process of learning how to adjust to a complex environment.

Driesch criticizes all the theories of transformism, as he calls it, on the ground that they really furnish no explanation of the facts, especially of the facts of regeneration. As a concrete example he takes the regeneration of the leg of a newt. "All

[1] J. A. Thomson, *The System of Animate Nature*, II, 363–367. (By courtesy of Messrs. Williams and Norgate, London, and of Henry Holt and Company, New York.)

individuals of a given species of the newt, say *Triton taeniatus*, are endowed with this faculty; all of them therefore must have originated from ancestors which acquired it at some time or other. But this necessary supposition implies that all of these ancestors must have lost their legs in some way, and not only one, but all four of them, as they could not have acquired the restitutive faculty otherwise. We are thus met at the very beginning of our argument by what must be called a real absurdity, which is hardly lessened by the assumption that regeneration was acquired not by all four legs together, but by one after the other. But it is absolutely inevitable to assume that *all* the ancestors of our *Triton* must have lost one leg, or more correctly, that only those of them survived which had lost one! Otherwise not all newts at the present day could possess the faculty of regeneration! But a second absurdity follows the first one; out of the ancestors of our newt, which survived the others by reason of having lost one of their legs, there were selected only those which showed at least a very small amount of healing of their wound. It must be granted that such a step in the process of selection, taken by itself, would not at all seem to be impossible; since healing of wounds protects the animals against infection. But the process continues. In every succeeding stage of it there must have survived only those individuals which formed just a little more of granulative tissue than did the rest: though *neither* they themselves *nor* the rest could use the leg, which indeed was not present! That is the second absurdity we meet in our attempt at a Darwinian explanation of the faculty of regeneration; but I believe the first one alone was sufficient."[1]

So much for the Darwinian theory. Now for his criticism of the Lamarckian. "There is finally one group of facts often brought forward against Lamarckism by Darwinian authors

[1] Driesch, *The Science and Philosophy of the Organism*, 1907, pp. 267–268. (By courtesy of Messrs. A. and C. Black, Ltd., London.)

which may be called the logical *experimentum crucis* of this doctrine, an *experimentum* destined to prove fatal. You know that among the polymorphic groups of bees, termites, and ants, there exists one type of individuals, or even several types, endowed with some very typical features of organisation, but at the same time absolutely excluded from reproduction: how could those morphological types have originated on the plan allowed by the Lamarckians? Of what use would 'judgment' about means that are offered by chance and happen to satisfy needs, be to individuals which die without offspring? Here Lamarckism becomes a simple absurdity, just as Darwinism resulted in absurdities elsewhere."[1]

We know that variations may lead to constant results (perhaps in some such way as Morgan describes); "but everything else, that is everything about a real theory of phylogeny, must be left to the taste of each author who writes on the theory of the Living. You may call that a very unscientific state of affairs, but no other is possible.

"And, in fact, it has been admitted by almost all who have dealt with transformism without prepossessions that such is the state of affairs. Lamarck himself, as we have mentioned already, was not blind to the fact that a sort of organisatory law must be at the base of all transformism, and it is well known that hypothetical statements about an original law of phylogeny have been attempted by Nägeli, Kölliker, Wigand, Eimer, and many others. But a full discussion of all these 'laws' would hardly help us much in our theoretical endeavour, as all of them, it must be confessed, do little more than state the mere fact that some unknown principle of organisation must have been at work in phylogeny, if we are to accept the theory of descent at all. . . .

"As we ourselves feel absolutely incapable of adding anything specific to the general statement that there *must* be an un-

[1] Driesch, *The Science and Philosophy of the Organism*, 1907, pp. 288–289.

known principle of transformism, if the hypothesis of descent is justified at all, we may here close our discussion of the subject."[1]

If any solution is possible, it will, according to Driesch, probably be found in the analysis of the operation of entelechy, which, though not material in itself, uses material means. "And therefore we shall close this discussion about the most problematic phenomena of biology with the declaration, that we regard it as more congruent to the general aspect of life to correlate the unknown principle concerned in descent with entelechy itself, and not with its means."[2]

This force, entelechy, becomes for Reinke, through his dominants, "an immanent teleological final cause."[3] Of course such a view of evolution — that evolution is a description of the unfolding of purpose — is essentially that of Royce, to which we have already referred and to which we shall have occasion to return.

It is rather remarkable that Bateson and Driesch, approaching the subject from wholly different points of view, should have reached a similar conclusion — that transformism as it now stands explains nothing and that some principle underlying all life must be involved. Their agreement is also interesting because of the contrast in their conclusions. Bateson looks for the explanation of the principle in mechanical terms, while Driesch holds that such explanation is impossible.

Looking at just the same facts, another class of writers like Verworn and Loeb draw very different conclusions. They recognize that some principle of organization is necessary in evolution as it is in all manifestations of life, but they find this principle of organization in the laws of physico-chemical systems; for them evolution is the transformation of a specific chemical system

[1] Driesch, *op. cit.*, pp. 291–292.
[2] *Ibid.*, p. 295.
[3] Herbert, *The First Principles of Evolution*, pp. 220–221, referring to J. Reinke's *Einleitung in die theoretische Biologie*, 1911.

according to its own laws of development acted on by natural selection. Loeb shows very clearly how he thinks the process has occurred. Blind fish are found in caves. This fact is sometimes held to be a case in which natural selection acted on small variations caused by the environment, till gradually a race was evolved that lived in caves and was blind. But what actually happens is this: "It is not the cave that made animals blind but . . . animals with a hereditary tendency towards a degeneration of the eyes can survive in a cave while they can only exceptionally survive in the open." [1] Blind fish, salamanders, and insects are common in caves, but some salamanders that live in caves are not blind. In North American caves are *Spelerpes maculicauda* and *Spelerpes stejnegeri* with normal eyes, *Typhlotriton spelæus* and *Typhlomolge rathbuni* with degenerate eyes. Why is *Spelerpes* not blind if disuse is the cause? A blind fish, *Typhlogobius*, lives in the open in California. Why is it blind? [2]

Six species of Amblyopsidæ live in caves; all have abnormal eyes. But one form found in the open has abnormal eyes too. So species may exist with abnormal eyes either in caves or out of them. Now, experiment shows that blindness in fish may be caused by crossing with widely different species. A hundred million crosses of teleost fish may conceivably be produced; many are possible, but of these only about ten thousand, or $1/100$ of 1 %, are able to live and propagate.[3] These facts indicate how species and varieties are formed and how they are fitted to their environment. If crosses happen to give abnormal eyes or blindness, under ordinary conditions such crosses could not survive, but in a cave where eyes are useless they do. Everything survives that can; innumerable variations arise, but only those that find themselves in an environment suitable to them can persist. Such a theory does not of course account for the

[1] Jacques Loeb, *The Organism as a Whole*, 1916, pp. 326–327.
[2] *Ibid.*, p. 320.
[3] *Ibid.*, pp. 6, 320–321, 315.

origin of variations, which make crosses possible; but it can be maintained that variations are due to physico-chemical causes and are combined by the process of Mendelian heredity.

The difficulties encountered by any theory of variation has led to the hypothesis that perhaps species are descended from several different original forms instead of from one common ancestor. At present there is insufficient evidence to make possible a decision between these two views.[1]

Bergson, in his remarkable book *Creative Evolution*, with remarkable scholarship and extraordinary skill joins in criticizing both the school of Lamarck and that of Darwin, more especially from the point of view of adaptation. His principle of organization is *l'élan vital*, which is neither mechanism nor finalism but out of which both come. But, "however vivid and impressive Bergson's illumination of the evolutionary process may be, examined carefully it turns out to be no more than a description of the different lines of evolution so far as known. It posits the original vital movement, but does not tell us why it was constrained to break up into different tendencies, and that of a particular kind and in a particular order; and this is, after all, what we are seeking for."[2]

Unsatisfactory as these theories as to the process of evolution are, we have nevertheless succeeded in tracing in a very broad way the whole process of evolution through the inorganic to the organic and through the organic to man. The concrete picture that results for most scientists is excellently described by Professor Harlow Shapley:

"In these three discussions I have made a hasty survey of high points in the development of the material universe as it appears to an experimental scientist. The wide valleys between these high peaks are crowded with unmentioned details, some

[1] D. H. Scott, "The Present Position of the Theory of Descent, in Relation to the Early History of Plants," British Association, *Report*, 1921, pp. 170-186.

[2] Herbert, *The First Principles of Evolution*, pp. 222-223.

known, mostly unknown. We have frequently bridged deep chasms with airy hypothesis rather than with solid observational fact. We had to do that and take the risks — or not travel. In the following paragraphs I shall give a brief summary of the hasty survey.

"Conceptual space is infinite, and conceptual time is eternal; and we human searchers in space and time inevitably find neither beginnings in space nor beginnings in time — of course we fail to find the ultimate when and where. In our search we have travelled rapidly, enthusiastically, and far, and many a puzzling knot unravelled by the road, but not the master-knot — not the master-knot of human fate (if indeed that be more than a trivial snarl), and not the master-knot of material origins. The origins elude us.

"In our survey we started in the most elementary manner. In the simple nebulous forerunners of the stars we find also the simple forerunners of the chemical elements — we find hydrogen, helium, nitrogen, carbon, and the unknown nebulium; simple chemical elements these are, from which heavier elements and the compounds form. But the lighter chemical elements are themselves but compounds of still more simple constituents — electrons and protons. They are but compounds of these negative and positive units of electricity. Beyond the electron and proton? What more fundamental than the fundamental electrical units? Let us take up another subject.

"The myriads of stars, we believe, have evolved from the nebulæ, following a sequence in temperature and in density directed by gravitational contraction. Gravitation may direct the evolution, but something else does the work. The necessary energy for radiation probably comes from the atoms themselves — possibly in the building up of heavy elements; possibly in the ultimate transformation of eight-tenths of one per cent. of the mass of every proton into radiant energy.

"The evolution of the gaseous stars through the successive types of spectrum, as arranged in the Harvard system, is now generally accepted. From birth, to extinction as a luminous body, the star slowly contracts, increasing in surface temperature throughout its giant stage, according to Russell's theory, then decreasing in surface temperature during the dwarf stage when the heat generated suffices no longer to balance the radiation from the surface.

"The contracting star frequently has enough energy of rotation to deform it, to distort it, to divide it into a multiple system. So long as the rotational velocity is small, the star is sensibly spherical; with increasing velocity it becomes flattened at the poles of rotation, and finally elongates and divides into a double system of elongated components.

"The birth of a planetary system, however, must be sought not in miraculous creation as depicted in the Mosaic cosmogony, not in rotation as suggested by the Laplacian Nebular Hypothesis, but in eruptive action. The near approach of two stars might easily result in a system such as ours — the planets being snatched out of the gaseous side of our sun, like the rib out of Father Adam. Born as gaseous masses, the smaller planets, like the Earth, would quickly liquefy at the surface.

"In the course of time — and there is plenty of that — the cooling earth reaches a temperature equilibrium, with a solid crust, and there evolves the chemistry of living things.

"One product of that chemical synthesis has interested himself in the prevalence of life in the other parts of the universe. The conditions appear unfavorable on all other planets of the solar system, at least for high forms of life. Indeed the possibility that life, just as we know it, exists anywhere else in the known stellar universe is very small. On the other hand, the probability is high that chemical operators of some kind exist on the planets of other suns; the chance that in some ways they

surpass our own development is as good as the chance that they fail to reach its height.

"The animal man may be unique to the earth, but life, broadly defined, is probably wide-spread. Under suitable conditions it may be one of the natural outcomes of the material development of the universe.

"The individual physico-chemical sequence — that is, nebula, star, planet, life, human mind, and onward — seems to be clearly defined. Likewise the mechanism of the whole sidereal system, when, if ever, we have fully worked it out, may be as clearly methodical. It now appears that the stars, after crystallizing out of chaotic nebulous clouds, are largely grouped into stellar clusters. The combination of such groups into larger systems results finally in a great, flattened, stellar structure — our galactic system of nebulæ and stars. The enormous mass ever increases at the expense of the once semi-dependent clusters that it absorbs. Within it the assimilated clusters are gradually digested and the component stars flung widely throughout its extensive plane.

"Far off from the centre of the Galaxy, is our own yellow, spotted, dwarfish star, already past the prime of life. Less than a billionth of the energy it radiates falls upon a planet infested with living things, which, in their clumsy ways, try to catch and use some fragments of the eternal spark.

"The mighty galactic system we are in, the only one we know, appears to be moving rapidly through sidereal space. Its dimensions are measured in hundreds of thousands of light years, its age in untold millions of centuries. Its mass and its energy, its future and its meaning — we only guess in our aspiring human way." [1]

[1] Harlow Shapley, "Notes on Modern Cosmogony," in *Harvard Alumni Bulletin*, xxv, 833-834 (No. 28, April 12, 1923). (Quoted by courtesy of the editors of the *Bulletin*.)

The picture of evolution is, however, incomplete without some mention of the evolution of society. We have already indicated that man is the result of an unknown process of transformation from some less-developed form like *Pithecanthropus*. It has also been suggested that far more important in human history than mere biological development are the environmental factors, the social heritage, the customs, institutions, laws, and ideals that form part of his environment. The question therefore arises, What determines the course of this social, or, perhaps better, this societal development? Any detailed consideration of this immense topic would lead too far; it is, moreover, unnecessary for our present purpose, and this for several reasons.

If we look in a broad way at the history of civilization, we see that its course is not uninterrupted but that it consists in a series of waves; civilizations attain a peak and then decline and perish, as did those of Assyria, Egypt, Greece, Rome. The vital question is, therefore, What determines the rise and fall of peoples? Many and various are the answers to this question:—

(1) The theory of the school of Buckle, which holds that the cause of the rise of a people is to be found in a happy combination of geographical conditions, and the cause of its fall in a general petering-out of the powers of the people so that they are unable to meet new conditions and compete with a more vigorous race.

(2) The theory of what may be called the school of Karl Marx, which maintains that civilization depends on the economic institutions that are invented to meet the conditions of the time.

(3) The theory advocated by Dr. William McDougall, that the rise and decline of races are due to innate qualities, the decline being especially connected with the inadequacy of the supply of leaders, a condition brought about by the relative sterility of the better-endowed classes.

(4) The theory that the rise and fall of peoples are due to the innate ability of individuals to vary biologically.[1] These variations are acted upon by natural selection and are largely determined by environment. One of the most important environmental influences is that of climate. Human beings cannot reach a high point of civilization in the Arctic regions, for all their energy is used up in acquiring the means of sustaining life. In the tropics the reverse is true: there it is impossible to exert energy because the climate kills off those who do. So the rise of a civilization would depend on the formation of an able race by variations that are selected and preserved by heredity; if this able stock found itself in the right conditions of climate, it would have a good chance to form a great civilization. Bricks to build with would, however, be necessary; which means that in addition to suitable climatic conditions material resources are necessary. The decline of peoples might be caused by changes in all these conditions.

(5) The theory of Hegel, that history is the process of the unfolding of ideas which have their reality in the absolute mind. These ideas progress by a process that may be described as the rise of a certain idea which has inner contradictions. By such an inner "negation" the idea is finally destroyed, and a new one arises which reconciles the inherent contradictions of the first but which itself is doomed to perish through its own "negation." This process continues until the absolute idea is reached, which is out of all temporal relations, which solves and reconciles all contradictions.

(6) The theory suggested by our quotation from Carlyle, that history is the process of the working out of the ideals of free men; that these ideals are given form by heroes, who embody

[1] A. G. Keller, "Societal Evolution," in *The Evolution of Man*, ed. G. A. Baitsell, 1922, pp. 126 ff.

the spirit of the age and give it direction, who by their example influence others and so determine the course of history.[1]

All these theories rest on the assumption that society, laws, customs, are founded on the actions of individuals; whether individuals are more than mere phenomena is at present immaterial. The laws of the development of society depend, then, on those which determine the development of human character. Our first step, therefore, in solving the problem of the rise and fall of nations is to determine what elements enter into character. But this is the main object of our quest, our immediate aim being to show that a theory of character which holds that character is purpose governed by probable laws — for example, by the laws of inheritance in their relation to environment — is the only hypothesis upon which a science of the detailed laws of character can be built. Upon such a general theory would depend the laws of the way character works and is developed. Some such general theory is necessary before a decision can be reached as to the merits of these different hypotheses about the rise and fall of peoples. This psychology of character unfortunately is not at hand. Until it is furnished, the larger question must be left unanswered.

So, in the theories formed to explain organic and human evolution we reach the same results that have confronted us throughout our discussion, some persons holding that a teleological explanation is necessary, some that mechanism accounts for all, others that there is no satisfactory explanation. It may be that the reason for this disagreement lies deeper than mere lack of knowledge of specific scientific facts. It may lie in the way in which scientists attempt to answer their problem; it

[1] Such summarizing of theories is imperfect and unjust. I have merely wished to suggest various trends of thought. For some discussion of such theories, see William McDougall, *The Group Mind*, 1920, and *Is America Safe for Democracy?* 1921.

may lie in the different interpretations of the constitution of reality. If this is so, then only philosophy can solve the puzzle by suggesting a different method of approach. "It is in the field of metaphysics rather than that of biology that the riddle of evolution will have to find its final solution." [1] But in some way, if the theory of evolution is to stand, an intelligible statement of the process must be formulated. Throughout our account little mention has been made of mind; but in man, the latest product of the evolutionary process on earth, mind is apparent. And here we reach the crucial test: How is a material account of reality to account for the existence of mind, the evolution of mind, and especially of the relation of mind to matter? We are thus led to the third group of opinions about scientific facts, those relating to the connection of body and mind.

[1] Herbert, *The First Principles of Evolution*, p. 318

CHAPTER XXI

BODY AND MIND

THE problem of the relation of body and mind is extremely complicated; but fortunately much of the detailed work has already been done by Dr. McDougall in his book on the subject, and our own contribution is implied in the preceding pages. Since the solution I advocate is in some respects different from Dr. McDougall's, it will add to clearness of exposition if I indicate the problem as it appears to me.

In the first part of our discussion of character we reached a tentative conclusion on philosophic grounds that reality is mental but that the physical world has a real existence apart from and in part independent of my individual mind. During our examination of the theory of evolution we have temporarily shelved this view of reality, and have provisionally attempted to describe the process of evolution as one that may conceivably be stated as a process independent of mind. At least we have tried to give full force to the arguments adduced in support of this position, and have suggested that, if one leaves out of consideration the last product of evolution, the human organism, and ignores the problem of knowledge, such a view is possible.

So it is perhaps theoretically permissible to regard organic nature as an uninterrupted process from a nebula to man. Let us for our present purpose still provisionally accept the reality of a material world, but let us adopt a view of evolution not so extreme as that we have just suggested; let us assume that from the appearance on the earth of the first organisms, about the origin of which we know nothing, there has been an uninterrupted development characterized by twistings and turnings

and retrogressions. Such a process may be figuratively described in the assertion that man has descended in an unbroken line from an ancestral amœba. Looked at objectively and abstracted from philosophic criticism, it can, it seems to me, be ideally described as a material process. In other words, we may say that the activity of mind is not necessary to explain the process; that actually I have no knowledge of other minds, either in amœba, worm, bee, dog, monkey, or man; that it is conceivably possible to describe the behavior of such phenomena in physico-chemical terms, so that organisms are conceived as machines, are automata.

But, although this is possible with regard to all organic reality except myself, who am a man, it does not appear so easy to conceive my own phenomenal activity as merely physico-chemical; for when I study myself I apparently observe what is called thought, mind. Whatever may be said about all other phenomena, the phenomena I seem to observe in myself are of two kinds, bodily and mental; and so a theory of evolution to satisfy what I apparently observe in myself must give an account of this phenomenon called mind. Before proceeding to a study of the theories of the relations of the mental to the physical, let me state what I believe are the observed facts about these two classes of phenomena, my body and my mind, and about their relations.

My body arises from a fusion of two cells which by repeated division and by specialization of function give rise to a cell-community that has a rough unity. In order that this community may act as a whole and adjust itself to its environment, some means of coördinating its activities are necessary. In man these means are furnished primarily by a specialization of cells into a machine for integrating the various activities of the cell-community.[1] These special cells are the nervous system, with

[1] Charles S. Sherrington, *The Integrative Action of the Nervous System*, 1906.

organs of sense at one end, the central nervous system in the middle, and the end organs of response at the other, respectively called receptors, adjustors, and effectors. The central nervous system may be figuratively and suggestively described as a number of segments or cylinders, one superimposed on the other.[1] Each segment has some individual duties, but all are connected by an extremely intricate web and are coördinated and in part controlled through the cerebral cortex. Thus, the knee-jerk is a spinal reflex; it is largely independent of the cerebral cortex, but its stimulus and the response are represented there.

This cerebral cortex is a marvellous mass of cells. "It is a remarkable fact that in man the cerebral cortex consists of layers of nerve cells so regularly arranged that a rough estimate of their number may be made. This is believed to be approximately 9,200,000,000. This prodigious number of cells is estimated to weigh a little over thirteen grams and to occupy the space of less than a cubic inch. When it is remembered that every human being develops from an egg cell of approximately one fifth of a millimeter in diameter and that this cell begins growth by dividing into two, and these two each into two thus making four, and then into eight, sixteen, thirty-two, and so forth, it will be seen what a stupendous process development is, even from the standpoint of simple numbers; for from this one egg cell by division must come not simply the nine billion and more cells of the cortex, but all the other countless billions of cells that go to make up the rest of the body. Nor is this process of cell multiplication, prodigious as its results show it to be, the only remarkable feature in development, for it is also equally striking that when the requisite number of cells have been produced the operation of cell division stops. At least this is true of the cortex, for here, as in a few other parts of the body, the

[1] Cf. Jacques Loeb, *Comparative Physiology of the Brain and Comparative Psychology*, 1900.

neurones change very little in number after birth. The brain cells with which the babe is born last for the most part without renewal through mature life to old age and death. What brings the operation of cell multiplication to an end at the appropriate moment is as little understood by embryologists as is the exciting cause of the initial increase.

"When it is recalled that the 9,200,000,000 cells in the human cerebral cortex are the nervous elements of this organ and that they collectively constitute rather less than a cubic inch of protoplasm, it seems almost incredible that they should serve us as they do. They are the materials whose activities represent all human mental states, sensations, memories, volitions, emotions, affections, the highest flights of poetry, the most profound thoughts of philosophy, the most far-reaching theories of science, and, when their action goes astray, the ravings of insanity. It is this small amount of protoplasm in each of us that our whole educational system is concerned with training and that serves us through a lifetime in the growth of personality." [1]

Looked at very roughly, the phylogenetic development of this central nervous system may be regarded as proceeding according to certain vaguely defined steps. There is first formed a structure roughly similar to a spinal cord, composed of segments which in part control segments of the organism but which are coördinated into a whole; gradually at one end of this cord larger masses of cells appear, forming ganglia, which take over some of the more general coördinating functions of the cord; gradually other ganglia are superimposed on these primitive brains, until in man we get the remarkable cortex just described.[2] Now, this process is also roughly repeated in onto-

[1] G. H. Parker, "The Evolution of the Nervous System of Man," in *The Evolution of Man*, ed. G. A. Baitsell, 1922, pp. 93-94. (Quotations are by courtesy of the Yale University Press, New Haven.)

[2] Loeb, *Comparative Physiology of the Brain*, etc., 1900; L. F. Barker, *The Nervous System and its Constituent Neurones*, 1899.

logical development; so that very roughly it is perhaps possible to say that we possess a nervous system which is built upon and preserves stages of development of the lower organism, and that the finished product is built upon these lower forms but has developed a new segment which utilizes and coördinates all the inferior ones.

There are of course other very important coördinating agencies in the higher organisms, — the various internal secretions, for example. The activities of the organs—such as testes, ovaries, adrenals, thyroid — that are concerned in forming various internal secretions are largely independent of the cortex; but since their activities in so far as they influence the behavior of the organism are probably always represented either directly or indirectly by processes in the cortex, we may for the purposes of this rough sketch conclude that the cortex is *the* organ of coördination.

But, looking at my own organism through the process of introspection, I am aware of phenomena which are called mental — sensations, pleasures, pains, emotions, thoughts. If I look at these phenomena more closely I see that certain very remarkable qualities are involved. These mental phenomena apparently remember other mental phenomena. This mysterious power called memory is a unique character. As Dr. McDougall has shown, habit and memory are distinct phenomena.[1] While we may suppose that the cortex stores up experience and gives rise to habits that may ideally account for human behavior, nevertheless introspectively this is not memory, for memory is a recognition that this present mental phenomenon is to be referred to the past. This thought I now have of Brest in 1918 refers to experience I then enjoyed. Such a reference and recognition are unthinkable in material terms. The fact that I had

[1] William McDougall, *Body and Mind*, 5th ed., 1920, ch. xxii, "The Psycho-Physics of 'Meaning'"; *Outline of Psychology*, 1923, pp 291–311.

experience in Brest undoubtedly caused changes in the so-called physical constitution of my cortex; these physical conditions may perhaps be conceived as being again called into action by present conditions; the totality of the past changes and the present conditions may give rise to present behavior; thus in a sense there may be a physical basis for memory. But the fact that I now recognize that this present thought of Brest is connected with my past, that I remember it is a symbol for, or means, the same experience I had before, is not the mere conjunction of similar physical events; it is a mental affair and for me an ultimate, unanalyzable fact.

Another aspect of mind, to which we have already referred, becomes apparent on further examination — thought shows a unity in multiplicity. This unity, according to Royce, whose account we accepted, is the unity of a meaning, of a purpose; the diversity is the astounding fact that this meaning always involves an infinite series for its fulfilment. Now, meaning, having a purpose, that which gives unity to the thought, is not a thing that can be expressed in material terms. The fact that the cortex acts as a whole and unifies the behavior of the body regarded objectively, is not meaning. Objectively, it is merely the combined activity of a mass of electrons acting as a whole. So is a stone, so is the planet Mars.[1]

We have already noticed the fact that a pain seems to be a distinct phenomenon apart from the possible motion of the molecules of the brain. When it is remembered that the agreeable or disagreeable (or possibly negative) feelings — phenomena not like the sensational pains of a toothache, but like the agreeable feelings we have when a piece of work goes smoothly — accompany all thoughts, and that these feelings can by no metaphor be held to *be* motions of molecules, one more dis-

[1] McDougall, *Body and Mind*, chs. xxi–xxii, "The Unity of Consciousness" and "The Psycho-Physics of 'Meaning'"; *Outline of Psychology*, *passim*.

tinction is added to the mental as opposed to the physical world.[1]

Apparently, then, we have two classes of phenomena which at least each individual may observe in himself, the mental and the physical. But further observations on these two classes of phenomena are possible. Many facts show that there is some relation between the two classes. The validity of these observations, however, rests on an argument from analogy, and therefore in some cases has a rather insecure basis. All observation concerning the relations of the two worlds rests primarily on the assumption that other organisms have thoughts, feelings. I cannot observe in myself that I have certain thoughts and then open my own skull and observe what changes go on in my brain; but, by assuming that a patient who dies of paranoia had thoughts similar to those I have when I act in the same general way the patient acted, I can after his death examine his brain and attempt to discover whether any abnormal changes have occurred there which may be connected with his abnormal thoughts. To be sure, I can do a certain amount of experimentation on myself, as for example by studying the effect of drugs or alcohol on my thoughts. But even the validity of such observations, I think, rests on the fact that it has been discovered by objective means, by experiments on animals and in other ways, that drugs do affect the physical conditions of the cortex. There is, however, a certain amount of evidence open to my own personal observation. I am aware, if I have ever been hit on the head with a baseball bat, that my thought was apparently suspended. In sleep, likewise, I no longer think; or, if I do, such thought is largely disconnected from my waking thought. Although such general observations do show some connection between thought and physical conditions, it does not seem probable that, without minute objective enumeration of these

[1] McDougall, *Body and Mind*, ch. xxiii, "Pleasure, Pain, and Conation."

physical conditions through physiological experiments, a very detailed account of the connection could be given. We must conclude, therefore, that the proof of such connection rests primarily on an argument from analogy.

No one seriously doubts that other human heings have thoughts. Their bodies and brains are like ours; they behave in similar ways. How far may we carry this argument from analogy into the organic realm? No one can say with assurance. If you read Hobhouse and McDougall, you will see that some authorities hold that the most minute organisms have thoughts, or perhaps mere feeling is a better word. If you read McCabe[1] and Loeb, you will perhaps douht whether this is a necessary assumption. In any case, with man, with yourself, you must admit that at least as a phenomenon thought exists. Of course my own opinion is that the whole of nature, organic and inorganic, exhihits a process which is similar in all realms. Although, as Dr. Henderson remarked in a lecture at the Harvard Club, Boston, it is difficult to describe this similarity, yet all who have reflected on cosmic evolution are convinced that the process as a whole, up to and including man and societal evolution, has something in common. This something I can find only in mind. Therefore let us for the present accept as a very probable and not an extreme view the opinion that even the minute organisms in the animal kingdom possess something akin to what in ourselves we call mind. Assuming this, it becomes necessary for science to state the connection, if any, between the observed classes of phenomena, mind and body.

It has often been maintained that this alleged fact, that consciousness is present throughout the animal kingdom, proves that there is some kind of at least semi-causal connection between body and mind. It is held that nothing is produced in the course of evolution which is not of use. Therefore, mind must

[1] Joseph McCabe, *The Evolution of Mind*, 1910.

be of use to the organism.[1] The force of this argument, I think, is destroyed by the criticism of natural selection formulated by Driesch, Bateson, and others, which points out that natural selection is a permissive force and that no end of characters which are useless exist in the world. Thought may be just such a useless character.

There are, however, a lot of facts that show some connection between the physical and the mental, and especially between the cortex of the brain and thought. For example, Hobhouse shows how the human mind may be considered as the result of a gradual development from lower forms;[2] and we have briefly sketched the manner in which the human body has thus developed. Now, these two developments have gone along with equal steps; the more complex organisms, especially the more complex nervous systems and the more highly developed brains, apparently accompany the more highly developed minds. Moreover, we have suggested that the development of the nervous system is figuratively the superimposing of new and more complex segments on more primitive elementary ones. Such a process is observable in mental development, both ontologically and phylogenetically. Thus the present human mind may be figuratively but suggestively described as a number of minds superimposed like a nest of boxes. So in a sense my mind is phylogenetically built upon the minds of the amœba, of invertebrates, of vertebrates, of *Pithecanthropus*, of Crô-Magnon, and upon the minds of historic man.[3] Ontogenetically it is built upon primal mental activities of organisms,—such as to get food, to drink, to rest. Upon these are figuratively imposed the higher mental activities and the highest, the pursuit of a rational ethical goal and the objective embodiment of such goal. But all

[1] McDougall, *Body and Mind*, ch. xx, "The Argument to Psycho-Physical Interaction from the 'Distribution of Consciousness'"

[2] L. T. Hobhouse, *Mind in Evolution*, 1915

[3] James Harvey Robinson, *The Mind in the Making*, 1921

these minds are in some degree present in the finished, unified product.[1] Mind, if it exists, and body, if it exists, show parallel and similar development, thus pointing to some ultimate connection.

Such general conclusions are supported by a mass of evidence drawn from human and animal pathology, from experiments on animals. Detailed examination of this evidence is unnecessary. It clearly shows some relation between brain and mind, however this relation is to be expressed.[2]

The evidence is summed up in a few words by Professor Parker: "When you prick your skin with a pin nothing seems more natural than to locate the sensation of pain where the pin abraded the skin and yet we know that the sensation of pain is in the cerebral cortex of the brain and not in the skin. The evidence that this sensation is resident in the cortex comes from several sources. First, it is known that if a nerve is cut, the part of the body supplied by that nerve loses sensibility. When a nerve going to a part of the hand is accidentally severed, a pin may be thrust into that part without producing the least sensation whatever, showing that the hand in itself is not endowed with pain. Not until the restoration of the nerve months after the accident does the sensation of the afflicted part return. Not only are there circumstances under which a part may be present though without sensation, but there may be sensations without the presence of any part. This condition is well seen in the so-called phantasmal extremities. Persons who have recently lost an arm or a leg often suffer from very intense pains apparently in the missing part. So real are these sensations and so definitely do they seem to be located in the lost member that it is often difficult to persuade the patient that the pains are not connected

[1] Abraham Myerson, *The Foundations of Personality*, 1921, especially ch. xi, "The Evolution of Character, with especial Reference to the Growth of Purpose and Personality."

[2] *Ibid.*, ch. i, "The Organic Basis of Character."

with the lost part and that some attention to that part is needed. Yet the surgeon knows perfectly well that these sensations are caused by small tumors on the cut ends of the nerves that formerly went to the lost extremity. On removing these tumors the sensations disappear. Both these lines of evidence show that painful sensations though commonly referred to the skin are really not situated there. They are functions of a more deeply located part. When the central end of the system in the cerebral cortex suffers destruction either by disease or accident, sensation disappears absolutely and completely, a condition that shows that the real seat of this phenomenon is not in the peripheral parts of the body, as commonly assumed, but in a deep portion of the central nervous system.

"This is but one example of many that go to show that personality, not only from its sensational side but from all other aspects of its nature, is a function of the nervous system." [1]

How are we to express this connection between brain and mind, which in man at least seems so well established? In considering the various answers to this problem two groups of facts must be borne in mind. The first great group includes those of the development of the organism. Man develops from the fusion of two cells, and his complex body, including his brain, which is connected in some way with thought, is a community of cells. The mere fact that the brain in man is connected with thought is, then, a case of the more general fact that cells in general, or at least a certain kind of cells, are so connected. When we remember the facts of human ontological development from single cells and of human phylogenetic development from single cells, it seems impossible to deny some sort of potentiality in cells that gives rise to thought. Such potentiality seems to me to be expressible only in the assertion that all cells are in some

[1] G H Parker, "The Evolution of the Nervous System of Man," in *The Evolution of Man*, ed G A. Baitsell, 1922, pp 82-83

way connected with mentality; that, if considered as physical entities, they bear something akin to what we call mind; if considered as immaterial entities instead of as bearers of minds, cells are minds. Mind, even in cells, always has the character of unity we have mentioned, and has certain other powers which, however undeveloped, are ultimate,—as activity, memory, discrimination. The second great group includes the facts that give rise to the point of view of physical science, which holds that cells are physico-chemical systems in which all the energy of the system is exhausted in its own physical activities; that, if all these activities were completely known, then the behavior of all such systems, including man, could be stated in physical terms. Our question, then, is, How can any intelligent statement be made which covers these two groups of facts? Let us survey briefly the answers that have been given.

There is, first of all, the answer of the pure materialists, that a certain combination of electrons which we call protoplasm *is* mind. The best expositions of such a view are given by Verworn, Loeb, and Holt.[1] Science does not ask why a thing is so; its sole function is to state the conditions under which any phenomenon is produced. The conditions under which thought is produced are a certain physico-chemical structure, in man the cortex of the brain. When science has described all the conditions of the cortex, then, it has fulfilled its task. The objections to such a theory are obvious, and especially from the point of view of evolution is this answer unsatisfactory. It means either that mind is a combination of the material elements, as water is a combination of oxygen and hydrogen, or that it emerges from such a combination. That mind is nothing but a combination of the material elements is inconceivable. That it emerges from such a combination is also difficult to conceive. When a new

[1] Max Verworn, *Die Mechanik des Geisteslebens*, 1914; Loeb, *Comparative Physiology of the Brain*, etc., 1900, especially ch. xix; Edwin B. Holt, *The Concept of Consciousness*, 1914.

thing emerges in physics, as water, all the matter and energy of one form pass over into the new form. But such a description does not apply to the emergence of consciousness, for here all the matter and energy are used up in the formation of protoplasm; nothing is left over for the formation of thought. Even if such an assumption were conceivable, it would leave the main problem of the function of consciousness unsettled. When from the union of oxygen and hydrogen water is formed, a new quality, wetness, results. This exhibits new activities and produces new results in the physical world. When consciousness arises or emerges, what does it do, how can it act? All the behavior of the organism is already accounted for. What relation can there be between that group of conditions we call the brain and this group we call consciousness? Some additions to such a purely materialistic theory are necessary in order to make it at all clear.[1]

Logically, perhaps, the next attempt to account for the connection of mind and body is the epiphenomenalism of T. H. Huxley, which holds that under the proper conditions a thought, an epiphenomenon, is caused which accompanies the brain process and *is* thought, but which does nothing to the brain process. As Dr. McDougall points out, such a view is inconsistent with the general physical conception that all the matter and energy in a closed system are conserved and merely change in form. Moreover, epiphenomenalism is not generally held by those who have critically examined the problem.[2]

We are thus led to the theory of parallelism, the essence of which is that the mental and the physical are two distinct worlds; the physical goes on by itself, but with certain, perhaps with all, physical processes and elements there is a mental element. When the physical elements combine to form a brain, then consciousness as we know it results. With certain brain

[1] McDougall, *Body and Mind*, pp. 126–127. [2] *Ibid.*, pp. 140–152.

processes are phenomenally connected certain mental processes; the succession of these brain processes is causally connected; so the succession of mental processes can be explained according to physical law and all human actions physically determined.[1] In so far as we ask for a causal explanation of mental processes, we must use this theory of parallelism. But another aspect of mental life is apparent: we have purposes. Mental life may be looked at as the unfolding of purpose; in this way we can understand mental life but do not explain it. This purposive world is divorced from the causal world. As far as psychology is a causal science, parallelism must be assumed.

Regarding the human organism as the result of divisions of a cell and a cell as the probable result of inorganic evolution, one is almost inevitably forced, on the theory of parallelism, to hold that all matter — electrons — is the bearer or bearers of mind. The complex human brain is a complex of atoms and the human mind is a complex of the minute minds borne by the atoms. This in one aspect was W. K. Clifford's belief, though, as Dr. McDougall points out, Clifford wavered between the view that atoms carry mind and the more radical opinion that atoms are minds.[2] Of course, if atoms merely carry mind, we can say that matter and mind are eternal and the origin of the human mind is the result of the evolution of original mind as that of the body is of matter. This of course leaves the world hopelessly dualistic.

Before criticizing this theory, let us look at some of the other forms of parallelism. Fechner holds that there is a mind-stuff

[1] McDougall, *Body and Mind*, *passim*, especially pp. 152–154; Hugo Münsterberg, *Psychology, General and Applied*, 1914, chs. ii–v.

[2] McDougall, *Body and Mind*, p. 130. In his article on "Body and Mind," a lecture first published in the *Fortnightly Review*, December, 1874, Clifford seems to favor a theory of atomic parallelism. In an article "On the Nature of Things-in-Themselves," published in *Mind*, January, 1878, he apparently decides that atoms are in a sense minds. See his *Lectures and Essays*, 1879, ii, 31–88.

which combines into higher forms to make larger minds. But the physical world is something. It is mind looked at from another point of view. All reality is one, but you may view this reality from two sides, as you may view a shield. From one side it is convex, from the other concave; thus, if you view reality from one side it is mind, from the other side matter. Reality combines to form human bodies and human minds. Such a view of reality is, I believe, also implicit in Münsterberg's division of psychology into causal and purposive: there are different views of the same reality, different ways of regarding it; as they are different views of the same reality, they must proceed in a parallel course, but one aspect does not act on the other.

There are two criticisms which apply to all theories like Clifford's atoms that carry minds and Fechner's little minds that combine and are manifestations of the same reality seen from opposite sides. The first criticism is the one we have already mentioned, that it is difficult to see how mental elements can combine without something to combine on. As we have already examined this difficulty, we may dismiss it with the remark that they combine because they were never separate, that consciousness is just such a multiplicity in unity, that, difficult as it is to conceive such fusion, yet phenomenally it seems a fact. Two germs unite and a new consciousness results; if all cells have consciousness of a sort, as we have assumed, then the community of cells we call the organism must in some way fuse into a mind which is a unified whole. So, if we accept the facts of the organism, as I assume Dr. McDougall does, then the fact of fusion of some sort is given. But Dr. McDougall holds that fusion is unintelligible unless there is something that combines the elements. Such a something is for him a soul. It is, however, difficult to state how the souls of two germ-cells can fuse to form one new one without also admitting the fusion of mental elements. To the necessity of assuming a soul we shall

return; so far as fusion alone is concerned, I believe that the facts are best described in the way I have indicated. The whole process is mysterious enough; but for the present at least, for the reasons given, it does not seem to me that the fact of fusion is disproved or that it is unintelligible if interpreted in the way which James suggested and which I have adopted.

But there is another objection to these theories as stated. They divide the world into two parts, mind and matter, which are eternally divorced but are two aspects of one substance. This latter way of stating the case is Spinoza's solution and also, I think, Münsterberg's and Paulsen's.[1] As Dr. McDougall well says, in so far as this argument rests on a metaphor, and in so far as this metaphor is drawn from the physical world, it does not apply; for we cannot get outside of reality and see that it has two sides, and even if we could these two sides would appear convex and concave, not mind and matter, so long as the world were viewed objectively. Moreover, all these two-aspect theories have the further difficulty that, no matter how you interpret ultimate reality, one activity viewed as matter goes on by itself, the other activity viewed as purpose or mind goes on by itself; there is no connection; therefore the activity of purpose in the physical world is illusion. But without a stable connection between the mental changes called purpose and the brain changes that produce bodily acts, no theory of life acceptable to common sense or to ethical philosophy is possible. So, looking at the difficulties of a dualistic theory, many have been driven to hold that all reality is mental. In this way, the origin of mind is avoided by admitting fusion, and the evolution of mind is accounted for. But even on such a theory, as James emphasizes in his relation of the long-span to the short-span activity, and as Dr. McDougall has also explicitly pointed out, the relation

[1] Friedrich Paulsen, *Introduction to Philosophy*, 2d American ed., translated by Frank Thilly, 1904. See also McDougall's discussion of Paulsen, in *Body and Mind*, pp. 134–135, 145

between purpose and mechanical law is left just where it was. Our brain states, interpreted as ideas or as little minds, in some idealistic accounts are determined by the laws of necessary causation; our purposes apparently are not so determined. What is the connection between these different orders of events?

Dr. McDougall is driven to the conclusion that we must assume a soul which unifies experience, remembers, and directs the short-span activities, the brain processes. Conceivably a soul can do this without exerting force, without converting energy, because it has been shown that "a force or stress applied to a moving body along a line of direction strictly at right angles to the path of its motion deflects the path of the body without doing work."[1] Thus the mind may conceivably change the direction of molecular motion in the brain without doing work, and in this way may direct behavior. Moreover, Dr. McDougall holds with justice that the laws of conservation and degradation of energy are purely empirical concepts that involve great difficulties when applied to reality as a whole, which is with difficulty conceived as a closed system. We may therefore, if necessary, disregard them in biology and psychology.[2] So here we have a theory of the relation of brain and mind which conceivably accounts for the interaction of the mental and the physical by means of a soul and yet preserves the reality of purpose.

It seems to me that Dr. McDougall's theory is the only dualistic one with which I am acquainted that does justice to the observed facts. It describes the way in which brain and mind are connected, for the soul is conditioned largely by the bodily activities; it preserves the unity of consciousness and

[1] McDougall, *Body and Mind*, p. 212. (Quotations are by courtesy of the author and of the publishers, Methuen and Company, Ltd., London.)

[2] *Ibid.*, pp. 215–216. The germ of this theory apparently originated with Descartes. See his *Passions de l'âme*, Part i, articles xl–l, especially xli and xliii.

gives some account of the mysterious activity called memory. It further shows how it is possible to conceive that purpose acts in the physical world. That purpose does act somehow is assumed in all daily life, and that it is a real activity is held by a host of philosophers, most of whom, however, by separating the world into two aspects, — like Royce's world of description determined by necessary law and his world of appreciation governed by purpose, or like Alexander's world as enjoyed and world as contemplated, or like Paulsen's world of science and world of metaphysics, — make an abstract division which is not real but which, when made, sunders reality into two independent parts. So that it is impossible to show how purpose acts in the real world in which we live. But, with all the respect I have for Dr. McDougall's theory, with the conviction, which I believe we hold in common, that some theory is necessary which shall preserve the activity of purpose in the physical order, nevertheless I believe that some modification of the statement of his theory is necessary. My reasons will soon appear; but before I state them let me mention one more theory of the relation of mind and brain.

James has called attention to the fact that there are three kinds of functions: a productive function, as in a steam-engine; a releasing function, as when one pulls a trigger; and a transmissive function, as when a musical instrument, an organ, transmits the idea of symphony. "My thesis now is this: that, when we think of the law that thought is a function of the brain, we are not required to think of productive function only; *we are entitled also to consider permissive or transmissive function.* And this the ordinary psycho-physiologist leaves out of his account.

"Suppose, for example, that the whole universe of material things — the furniture of earth and choir of heaven — should turn out to be a mere surface-veil of phenomena, hiding and keeping back the world of genuine realities. Such a supposition

is foreign neither to common sense nor to philosophy. Common sense believes in realities behind the veil even too superstitiously; and idealistic philosophy declares the whole world of natural experience, as we get it, to be but a time-mask, shattering or refracting the one infinite Thought which is the sole reality into those millions of finite streams of consciousness known to us as our private selves.

"'Life, like a dome of many-colored glass,
Stains the white radiance of eternity.'

"Suppose, now, that this were really so, and suppose, moreover, that the dome, opaque enough at all times to the full super-solar blaze, could at certain times and places grow less so, and let certain beams pierce through into this sublunary world. These beams would be so many finite rays, so to speak, of consciousness, and they would vary in quantity and quality as the opacity varied in degree. Only at particular times and places would it seem that, as a matter of fact, the veil of nature can grow thin and rupturable enough for such effects to occur. But in those places gleams, however finite and unsatisfying, of the absolute life of the universe, are from time to time vouchsafed. *Glows of feeling, glimpses of insight, and streams of knowledge* and perception float into our finite world.

"Admit now that *our brains* are such thin and half-transparent places in the veil. What will happen? Why, as the white radiance comes through the dome, with all sorts of staining and distortion imprinted on it by the glass, or as the air now comes through my glottis determined and limited in its force and quality of its vibrations by the peculiarities of those vocal chords which form its gate of egress and shape it into my personal voice, even so the genuine matter of reality, the life of souls as it is in its fullness, will break through our several brains into this world in all sorts of restricted forms, and with all the imperfec-

tions and queernesses that characterize our finite individualities here below.

"According to the state in which the brain finds itself, the barrier of its obstructiveness may also be supposed to rise or fall. It sinks so low, when the brain is in full activity, that a comparative flood of spiritual energy pours over. At other times, only such occasional waves of thought as heavy sleep permits get by. And when finally a brain stops acting altogether, or decays, that special stream of consciousness which it subserved will vanish entirely from this natural world. But the sphere of being that supplied the consciousness would still be intact; and in that more real world with which, even whilst here, it was continuous, the consciousness might, in ways unknown to us, continue still." [1]

This theory is criticized at considerable length by Dr. McDougall,[2] one of the chief objections being that the separate streams or jets of consciousness transmitted by the brain necessitate something, a soul, to combine them. If the question of the soul is laid aside for the moment, the chief objections to James's transmission theory are that it not only does not meet our epistemological criticism of the reality of a material world, but, as stated, furnishes no inkling as to how mind can act on the brain and so influence human behavior; for on his theory the brain exercises merely a transmissive function.

Although the more logical procedure at this point might be to sum up the result of our survey of scientific facts and complete our original plan of testing our theory of reality by an application to all these opinions, finishing with the theories of the relation of body and mind, yet, for the sake of brevity and perhaps of clearness, let us first criticize these theories which we have just briefly stated, and first of all let us reject, with Dr.

[1] James, *Human Immortality* (Ingersoll lecture, 1897), 1898, pp. 13–18. (Quoted by courtesy of the Houghton Mifflin Company, Boston.)

[2] McDougall, *Body and Mind*, pp. 358–363.

McDougall, pure materialism and epiphenomenalism, which is merely a form of materialism. If this is allowed, we are free to consider two specific theories, that of Paulsen and that of McDougall. Both of these authorities approach the subject in a way which I have followed to some extent, and of course I am much indebted to them. From a consideration of similar facts in nature they reach different conclusions; the solution I shall urge differs from both but is, I hope, not wholly inconsistent with either.

Dr. McDougall states the whole problem most clearly. "We affirm that each of us can escape from Solipsism only by an act of faith or will that posits a real world, of which he is a member. This real world appears to each of us in the form of the phenomena of sense-perception; but, if he is not to remain a solipsist, he must affirm and believe that these appearances are not created by himself, but are rather due to influences or existences, not himself, yet affecting him. Or, in other words, he must believe in the validity of the category of causation; for only by believing that his perceptions are caused by some influence, some real being, other than himself, can he escape from Solipsism. Let him conceive these influences or existences how he will, and the psycho-physical problem still confronts him and clamours for an answer. For among these appearances is that which he calls his body, one among many similar appearances, and this appearance points to some reality beyond it, and the psycho-physical problem is — What is the relation of my thinking self to this reality beyond? He may accept Berkeley's suggestion, to the effect that the body and all other appearances are produced in his thought by the direct action of God, a pure spirit or thinking being like himself; but, even if he brings himself seriously to believe that God has chosen to play this monstrous joke upon mankind, he is but solving the psycho-physical problem by arbitrarily choosing a peculiar and dogmatic form of Animism.

"Or let him, with Herbert Spencer, affirm that this reality is unknowable; his need is then all the more urgent for some understanding of his relation to the appearances of which his body is one, since these appearances are all he can ever know.

"Or, if he holds that we must be content to affirm that this reality is of the nature of mind or spirit or consciousness, without further specifying it, then he still must discover the nature of the relation between his own consciousness or mind and that other consciousness which appears to him under the form of his body." [1]

The whole problem, in whatever terms it is stated, is, in the words of James, the relation of the long-span activities of reality to the short-span activities. With Dr. McDougall's formulation I most heartily agree, provided one interprets the words consciousness and mind to mean thought, mentality, and not a specific entity like a soul, and if one understands the category of causation to mean the probable, not the necessary, sequence of events.

Paulsen, after viewing the facts of nature less concretely but far more entertainingly than I have done, reaches the conclusion that philosophically nature is mental and must be interpreted in terms of purpose. But looked at scientifically, since we *must* believe in *necessary* causation, the world must also be conceived as a mechanism.[2] Commenting on this conclusion, James says, "Paulsen's *Einleitung* is the greatest treat I have enjoyed of late. His synthesis is to my mind almost lamentably unsatisfactory, but the book makes a station, an *étape,* in the expression of things." [3] Paulsen's conclusion is unsatisfactory because it does not solve the problem; it gives it up, as do all two-aspect theories. But such a confession of defeat is unnecessary. Let us

[1] McDougall, *Body and Mind*, pp. 180–181.
[2] Paulsen, *Introduction to Philosophy*, 1904, pp. 161–164.
[3] James, *Letters*, 1920, i, 310. (Quoted by courtesy of the editor and of the Atlantic Monthly Press, Inc., Boston.)

ask on what his conclusion rests. It is evident that it depends on the assumption that natural causation is *necessary*. This we have tried to show is not so; the sequence of events is only a probable sequence. This view of causation disposes of the necessity of Paulsen's conclusion, but does not give an answer to our problem. It is possible that purpose acts in the physical world, but the questions arise whether it does or does not act and whether we can state intelligibly how it could act Let us first try to state how it could act.

We have already mentioned the theory of Animism, defended so ably by Dr. McDougall. The theory I advocate has much in common with his; at least it has agreement on the supreme issue, that purpose is active in the so-called physical world. Since I believe that the description of mind and the manner in which purpose acts are better expressed in other terms than those used by Dr. McDougall, the clearest way of meeting the issue is perhaps to state my own theory, — or rather the old theory which I defend, — answer some objections raised by Dr. McDougall to such a theory, and endeavor to indicate the reasons I have for preferring such a statement of the solution.

Looking at nature from the point of view of epistemology, from that of the problem as to how we can know nature, and from that of the general evidence of scientific opinion and facts, I am driven to conclude that reality is mental. The physical world is that part of my thought which is common to you, to me, and to the object. Objects in the physical world act in relatively, perhaps in some cases absolutely, fixed ways. These habits are the laws of nature and it is very probable that the sequences we observe will continue. There is no contradiction in thinking that they may not be, and that some activities of nature actually are not, fixed. For me the psycho-physical problem is the relation between the relatively fixed activities of nature and the more fluid, creative ones which we call purposes. When I ask

in what the success of physics consists, I find, first, that it reduces all reality to one kind of substance, and that what this substance is does not matter for physics; so, if for epistemological reasons I conclude that this substance is mind, but mind existing in partial independence of *my* mind, the realities of physics are preserved. I find, moreover, that physics succeeds in describing reality by assuming minute existences which combine to form larger aggregates, including man. Lastly, I find that it is able to predict the course of events and to unify the behavior of these entities by discovering laws of their probable behavior. I therefore wish to attempt to apply to the evolution and constitution of mind these physical methods which have had such great success. But here a difficulty presents itself: How can minute minds conceivably fuse into one mind, — for we must all admit that thought has unity? This is one of Dr. McDougall's objections to any mind-dust theory. My answer to this objection has been given, following James. The mind is a unity because the parts into which it is divided are never really separate parts but elements which are discriminated in a whole. Thus the elements of physics, our monads, are merely convenient ways of describing reality, which actually exists as a unity in multiplicity. The problem of the one and the many is of course very puzzling for philosophy. My answer to it is that the unity of many diverse parts is observed in any organism, and especially in the activity of thought, which, while having a meaning, divides into an infinite series, as we saw in Royce's example of the map of England. So, while I think the argument against the possibility of the compounding of consciousness is to a certain extent valid, yet I think that, as a mode of description, we may use elements which combine.[1]

[1] Cf. S. Alexander, *Space, Time, and Deity*, 1920, ii, ch. i, A, "Mind and its Neural Basis"; L. T. Troland, "The Significance of Psychical Monism for Psychological Theory," in *Psychological Review*, xxix (1922), 201–211. Cf. also, in *Life and Finite Individuality*, edited for the Aristotelian Society by

But we still have the problem of how my purpose can influence my body, how thought can influence processes in the brain. This we have answered by denying that the problem exists. If you suppose that thought *is* the combination of all the thoughts of the cells of the body, then if I have a purpose it will be because the whole community of monads has this purpose and is attempting to carry it out. When you ask how the body accomplishes its purpose in the rest of the physical world, my answer is that it does this by learning how the other minds in reality actually behave and by taking advantage of this knowledge. Such an account, though manifestly imperfect, especially in giving any inkling as to why a stone should move on impact from my arm, does give some idea of how purpose may conceivably work, and it eliminates the problem of how thought acts on brain states. All this does not, however, even with the qualifications noted, solve the whole problem.

We have assumed certain habits in the world, the laws of the physical world; purpose must act on habit, or at least through habit, if it is to accomplish anything. How purpose works can be dimly perceived by observing what happens in ourselves. If you will read James's chapter on "Habit" in his *Psychology*, you will see that a mature individual is largely a mass of habits. How are these habits formed? My answer is that it is by the activity of purpose, either directly or indirectly. Take a simple example: I am taught as a child to brush my teeth; after some years I recognize that this is useful, and finally the habit becomes so fixed that it goes on almost unconsciously. But it originated in purpose and serves purpose, for without these fixed ways of behavior my life would be consumed in debating whether to brush my teeth or not. The fixed modes of behavior

H. Wildon Carr, 1918 [Supplementary Volume I], the symposium "Are Physical, Biological, and Psychological Categories Irreducible?" (*I*, J. S. Haldane; *II*, D'Arcy W. Thompson; *III*, P. Chalmers Mitchell; *IV*, L. T. Hobhouse; *V*, J. S. Haldane).

of reality, the habits, are purposes which, by a process of trial and error and final success giving satisfaction, have been found to work. In this way I conceive of the whole cosmic proccss. Many trials have resulted in partial successes giving some satisfaction; these have become relatively fixed habits of the behavior of reality. My individual purpose, accepting perforce these fixed ways of acting and making use of them for my own ends, enables me to economize endeavor, to formulate new purposes; and, by choosing certain habits of parts of nature to carry out these purposes, I may really create a new reality, a new way of behavior. My individual purpose is the purpose of all the elements that make up my organism; the bodily aspect of this organism, its so-called material part, the cells of my cortex, are what part of this whole activity is common property. My purpose — and all purpose — tends to become habit, thus leaving room for more trial and error and success. Hnbits when conceived as common property are the laws of nature. Such is the theory of the constitution and evolution of mind, and of its relations to the body, which I advocate.

There is one point, the necessity for postulating a soul, which needs further consideration. To this we shall immediately turn; but first let me call attention to the main reasons why I interpret the activity of purpose in different terms from those adopted by Dr. McDougall. The chief of these is the epistemological one, that dualism of thought and material nature does not give a satisfactory account of knowledge. Moreover, I believe that the idealistic account is actually more in accord with the observed facts of science than is the dualistic one. This I shall try presently to show. It must, however, be noted that Animism can be stated in idealistic as well as in dualistic terms: an archmonad, a soul, may be the unifying and controlling entity.

One of the main arguments for a soul is that used by Dr. McDougall, that something is necessary to combine elements. This

objection I have answered as well as I can. James has summed up the whole matter in a passage cited by McDougall: "Yet it is not for idle or fantastical reasons that the notion of the substantial soul, so freely used by common men and the more popular philosophies, has fallen upon such evil days, and has no prestige in the eyes of critical thinkers. It only shares the fate of other unrepresentable substances and principles. They are without exception all so barren that to sincere inquirers they appear as little more than names masquerading — Wo die begriffe fehlen da stellt ein wort zur rechten zeit sich ein. You see no deeper into the fact that a hundred sensations get compounded or known together by thinking that a 'soul' does the compounding than you see into a man's living eighty years by thinking of him as an octogenarian, or into our having five fingers by calling us pentadactyls. Souls have worn out both themselves and their welcome, that is the plain truth. Philosophy ought to get the manifolds of experience unified on principles less empty. Like the word 'cause,' the word 'soul' is but a theoretic stop-gap — it marks a place and claims it for a future explanation to occupy.

"This being our post-Humian and post-Kantian state of mind, I will ask your permission to leave the soul wholly out of the present discussion and to consider only the residual dilemma. Some day, indeed, souls may get their innings again in philosophy — I am quite ready to admit that possibility — they form a category of thought too natural to the human mind to expire without prolonged resistance. But if the belief in the soul ever does come to life after the many funeral-discourses which Humian and Kantian criticism have preached over it, I am sure it will be only when some one has found in the term a pragmatic significance that has hitherto eluded observation." [1]

[1] James, *A Pluralistic Universe*, 1916, pp. 209–210 (quoted by courtesy of Messrs. Longmans, Green, and Company, New York). See McDougall, *Body and Mind*, pp. 361–362.

There is of course a pragmatic reason for assuming a soul — the ethical one of preserving the worth of human endeavor. This may be one of Dr. McDougall's chief reasons for adopting the hypothesis, although he does not definitely say so. It is a weighty reason, but one the consideration of which I must again postpone. Unless for ethical reasons a soul is a necessary postulate, it seems to me that for science it is an unnecessary assumption and a very troublesome one. We have seen that organisms result from the fusion of two cells, one from each parent, and that mental traits are inherited by the offspring. Does this mean that the two germ-cells each carry a soul and that these souls fuse into one when the germ-cells unite? The impregnated ovum divides and the parts again divide, and some of the divisions form new germ-cells which transmit mind to its descendants. Does the soul divide with these divisions, a part going to the brain, a part to the germ-cells? If you deny that the soul is connected with the germ-cells, then you must say it is added to the body at some stage of its development. But at what stage? When the nervous system is formed, at birth, a month after birth? Why does the new soul resemble its parent? To such questions the advocates of a soul must find answers.

There are, then, three modifications I should like to make in Dr. McDougall's theory. (1) Provisionally, from a scientific point of view, it would seem as if we could get along without a soul. (2) The compounding of mental existences in the provisional sense we have described is permissible and necessary for purposes of description. (3) If my theory of knowledge is right, the relation between body and mind is not strictly psychophysical but is a relation between purpose and habit. Besides the objections to such a theory already mentioned, there are more concrete ones, especially those concerned with the inheritance of habits, which are of course acquired characters. The

consideration of this objection I should also like to postpone for the moment.

It has fortunately been brought to my notice, just as this book was going to the printer, that Dr. McDougall himself has supplemented his account of body and mind. In his presidential address of 1920 to the British Society for Psychical Research,[1] he accepts a theory of monads at least as a descriptive device, without committing himself to any metaphysical theory about monads except that they are not wholly material. He holds, as I understand him, that the human organism may be best described as a multitude of monads ruled by an arch-monad, a soul, which acts through subordinate officers and is influenced in turn by them. Such a theory can be expressed either in dualistic or in mental terms. It has the advantage of avoiding the difficult problem of the compounding of mental entities; for the arch-monad is a unity and yet is aware of some of the activities of the other monads in the body. If we suppose with McDougall that this arch-monad may enter into other combinations after the dissolution of the society we call the body, and if we suppose that the arch-monad can remember its own special activities as ruler of the society, then we have a basis for personal immortality. Much support for such a theory is given by cases of dissociated personality. However, if it is admitted that possibly mental elements may combine into wholes, then such multiple personalities can be equally well stated in terms of the theory I have suggested. Whether Dr. McDougall's hypothesis describes the facts more adequately, is the more logical, and better fulfils the ethical demand for the preservation of human endeavor, are questions that must be left to the judgment of the reader. It has given me much satisfaction to discover that at least in some respects my theory agrees with his.

[1] Society for Psychical Research. *Proceedings*, xxxi. 105–123 (Part lxxx. 1920).

The first part of our problem, that of showing how purpose may work in the world, is then answered, however imperfectly. Conceivably purpose may operate in the world, but does it? The answer to this second part of our problem has also already been given. Through observation of ourselves we think we observe that purposes work. It is difficult to prove that they do; all may be probable sequence of events determined by physical law. But we have seen that in a sense the whole physical world is a postulate, is a theory made to explain experience, to make life possible. Logically we are forced, if we criticize deeply enough, to reach the position of Santayana and McDougall, that criticism leads to scepticism; to make even science possible, we must, then, have faith. As I look at it, the whole world of science is the result of a practical endeavor to unify experience so that I can control it for my purpose. That purpose is active in the world thus becomes a necessary postulate for the very existence of science. Without purpose, science is nothing, life a sham.

CHAPTER XXII

APPLICATION OF THE THEORY OF MONADS TO THE THEORY OF EVOLUTION AND TO THE THEORY OF CHARACTER

We have now completed our survey of the concrete facts of science, and have made some critical remarks, especially on the theory of the relation of body and mind. We have seen that an ideal, imaginative account, wholly in mechanistic terms but with many gaps, is often given of the process of evolution from nebula to man. But we have also seen that an epistemological dualism is unintelligible, and, through our attempt to formulate how thought could result from such a material process and how thought could act in it, we have also concluded that dualism is inconceivable, that reality is mind. It remains to apply this theory to the concrete facts of science; for, if there are any such facts that are manifestly contradictory to it, our theory must be in whole or in part false.

We have examined in a brief and hurried manner some examples of many kinds of realistic thought — philosophical realism, scientific realism, and the facts, which are often really the opinions, of science. We must now draw our lesson from this survey, and we must use great care in reaching our conclusions. In the account of the opinions of science it is evident that the authorities quoted are of various degrees of eminence and that some are of more recent date than others. How, then, can any valid conclusions be drawn except from the most recent opinions of recognized authorities? The opinions that have been quoted were selected to emphasize broadly contrasted ways of thinking about reality, and for this reason extreme positions were often

selected; but I hope the more conservative opinions have also been noted. Thus Verworn and Loeb, while recognized authorities, are extreme in their opinions and often, especially Verworn, very dogmatic. But I hope that any vitiating influence from inaccuracy of statement of the most generally accepted scientific opinions, either of observed fact or of interpretation, has been avoided by the very general nature of the conclusions reached. Therefore the results of this scientific investigation will, I trust, be stated in such general terms that the influence of specific opinion, which varies with the observer and with the time of the observation, will be eliminated.

So it is evident that there is a grave danger to be avoided in drawing conclusions from specific scientific facts. The facts of science of to-day are not the facts of science of yesterday and will not be those of to-morrow. Science is a growing mass of opinion about reality. We must not base a theory of character on facts which to-morrow may be found to be not facts. But one of our chief motives in embarking on the quest for scientific truth was the hope that we should find that science gives facts, not opinions; for science, it was thought, had a value in the money market, while philosophy apparently had no such value. Are we then to conclude that this practical value of science is illusory? This question must be answered in the negative: science does give some measure of truth. But how are we to decide, from the mass of conflicting evidence and diverse interpretation, what truth science contains, what is mere changing opinion, what is probable fact? We have repeatedly emphasized the belief that science gives us all the information we possess about the behavior of reality. As Paulsen says, "a question of facts can be decided only by experience." [1] A philosophy that is to tell us anything about the behavior of reality must appeal to

[1] Paulsen, *Introduction to Philosophy*, 1904, p. 85. (Quoted by courtesy of Messrs. Henry Holt and Company, New York.)

experience; a philosophy that tells us nothing about the behavior of reality is useless. So for me philosophy is largely the attempt to sift and criticize the changing opinions of science, in an effort to discover what are the most probable facts. It behooves us then, as empirical philosophers, to examine very carefully this body of scientific facts in order to discover if there is not something which is probably established, some body of facts on which we may build a theory of the behavior of reality; for only in this way, apparently, can such a theory be formed.

Looking at science in a broad way, we arrive at certain conclusions which, I believe, no one can practically doubt. For the sake of brevity, I am going to state dogmatically as established facts the conclusions that appear to me justifiable, but with the full knowledge that my statement of facts will include too little for some scientists and too much for some philosophers. Some of these conclusions are more probable than others; the less probable I shall endeavor to label as such. Whether the conclusions are legitimate I must leave to the judgment of the reader on the evidence submitted, but I shall of course try to avoid the danger of building on insecure foundations.

(1) The first conclusion to be drawn from the facts of science is that reality behaves in part, at least roughly, according to law: oxygen and hydrogen, so far as observed, always combine under certain conditions to form water. There is a vast body of such well-established facts; other facts, as the assertion that metabolism is a special form of osmosis, are not so well established. But we may safely believe that a large part of reality acts in relatively fixed ways and that many of these ways are known to science.

(2) The second conclusion to which I wish to call attention is more problematical. Science usually, but not universally, holds that the laws of the fixed behavior of reality are necessary, *a priori* laws, that they are laws of necessary causation. But such

a conclusion, for the reasons given in our discussion of causation, is unfounded. The laws of science are only very probable laws. This does not mean that reality does not act in at least relatively uniform ways, it does not mean that the future is wholly unpredictable. On the contrary, the great discovery of science is that reality does behave in relatively fixed ways.

(3) Science assumes as its fundamental concept that this reality the behavior of which it in part describes exists independent of my individual mind. Some scientists go much farther and hold that this reality exists independent of all mind, as matter. It does not seem as if such a conception were necessary to science, for we find science progressing in spite of the most varied views as to what this reality is. If Mr. Eddington is right, any kind of reality that is partly independent of my mind will suffice. We have given some philosophical reasons, which appeal to many, for rejecting the materialistic theory. In view of such difficulties and of the varied opinions as to the nature of reality, let us accept the conclusion that very probably, in my scientific sense of the word probable, a reality partly independent of my mind exists, but that this reality may be mental.

(4) There is also the observed fact that, at least phenomenally, something described as mind, thought, feeling, sensation, exists, which science as a whole must include in its account of reality.

(5) It also seems as well established as anything can be that reality exhibits parts and that additional means of discrimination disclose smaller and smaller parts. We must not hastily conclude that separate parts are necessary to a description of reality, but the observed fact must be taken into consideration.

It is evident that even such very general conclusions as these are not acceptable to all minds; some of them have been, and still are, disputed by scientists, others by philosophers, and some by both. But from our examination of philosophical and scien-

tific concepts, it has become clear, I think, that no *a priori* construction of reality is possible; that philosophy is an induction from experience, using experience in a very wide sense; that nothing *certain*, nothing necessary, can result. The conclusions that have thus far been formulated are, I believe, very probable. My main reason for believing so is that they have served their purpose in giving control of nature. But a further reason for holding these views I shall attempt soon to formulate — they will, if accepted, reconcile many apparently opposed views. That this is a trivial ground for adopting the theory I do not believe. If many acute minds looking at nature have reached opposing conclusions, have emphasized divergent points of view, there must be some reason for this divergence; it is probable that a certain measure of truth is contained in both or all of the conflicting views. Before insisting on this point, however, we must mention some other more concrete and perhaps for this reason more theoretically uncertain facts. These are implied in our survey of the concrete descriptions of science given in the theory of evolution.

(6) The most general of these facts is that the universe shows an orderly process of development, all the specific steps of which are not known; but all scientists agree that there has been a transformation of species on the earth resulting in man. This conclusion we are forced to accept.

(7) There is a vast amount of evidence, which is continually being augmented, that at least tends to prove that the processes which go on in the organic world — reproduction, life, growth, metabolism — are identical with processes in the inorganic world. That this is true is shown by the experimental work on all these organic functions, of which we have tried to furnish a suggestive but by no means complete account. This evidence I accept as furnishing, on the whole, a great probability that the organic and the inorganic are fundamentally identical. Such a

conclusion means just what it says. It does not mean that the inorganic is necessarily material and that consequently the organic is material too, a view which, though generally accepted, is a wholly unjustifiable conclusion in so far as the mere experimental facts are concerned.

(8) But, although we accept these facts about the organism as giving a strong presumption that fundamentally the organic and the inorganic are one, we have noted that *throughout* the discussion of evolution two opposing views are held. One opinion is that all evolution is a material process; the other is that teleology, purpose, something akin to the mental, something at least non-mechanical, is involved. This latter view is held in a variety of forms, from Driesch's opinion that mechanism is not all, to Royce's that reality is not mechanism but is purpose in its ultimate nature. For me, the persistence of the two views is an observed fact, a fact that philosophy must take into consideration. It seems to me unlikely that, when two views have been so persistent throughout history, have been held by so many men of acute intellect and are still held by such individuals, either view is wholly wrong. A theory, to be adequate, must take into account this fact of opposing interpretations and try in some way to reconcile them.

(9) All the accounts of reality, materialistic, dualistic, idealistic, suppose that there is some kind of activity very real and very universal.

(10) A survey of evolution as a whole and of organic evolution in particular shows that this activity is a creative process, that in some way the new is formed. An account of how this something new is formed must be given by an adequate scientific theory.

(11) There are other aspects of these scientific facts on which we may fairly agree. The organism, so far as observed, is always produced from another organism. In their complex

forms, organisms result from the continued division of cells. Whether we regard life as co-existent with matter or as evolved out of matter, a human being is the result of an infinite process and is a cell-community which is a unified whole.

(12) As an observed fact, life is always connected with a special aspect of reality called protoplasm. When protoplasm relapses into its elements, the phenomenon we call life vanishes. In man at least, conscious activity is likewise connected with this mysterious substance. So far as observed, when protoplasm disorganizes consciousness ceases.

(13) Protoplasm has the power of passing on certain characters to its offspring through heredity. In man this power is a property of the germ, and must, I think, be conceived as an infinite power, or at least as an unlimited one, since the process of evolution shows continued change without beginning and implies that the past is preserved in the germ nnd transmitted to the descendants.

(14) Environment, so far as is now known, is an element in development equally important with heredity, for it is environment that calls forth the inherited powers inherent in the individual.

(15) In man a phenomenon is observed which may be ignored in other forms of the appearances of reality. Through introspection, as has already been mentioned, it becomes clear that mind, thought, feeling, phenomenally exist. Mind has characters that apparently and probably distinguish it from what is meant by matter; it has unity in diversity, it remembers, it recognizes degrees of likeness and difference.

(16) Another fact established by numerous observations is that mind and body are related in some way.

(17) In nddition to these facts, which are all more or less probable but which, I believe, we must accept, there is nnother fact of a more debatable nature. This is the opinion held by

many that purpose is operative in the world, and not only in the mental but also in the so-called physical world. If this is a fact about reality, it is necessary to show that purpose really acts and in some measure how it can act. Our most general reason for holding that purpose acts in the world, it will be remembered, is that without purpose, without meaning, the whole structure of science falls to the ground. Science exists because we have a purpose to unify experience, to get truth. If we deny the reality of purpose, we are led to absolute scepticism. Another general reason is that an explanation of reality in terms of the purposive activity of mind is the only one that reconciles conflicting opinions and makes science intelligible as the laws of the creative advance of nature. A final reason is that without the efficacy of purpose life becomes meaningless. It may be that life is meaningless; but such a view is inconsistent with the implications of all daily life, with the implications involved in all human endeavor. As my whole thesis, with all its separate divisions, is an attempt to show that the activity of purpose is the most rational solution of the constitution of reality, the demonstration of this theory really rests on the general success which such a theory has in making experience, including a theory of knowledge and the facts of science, intelligible. It now remains to draw what conclusions we can from the scientific facts.

During our survey of the doctrine of evolution we accepted provisionally the dualistic view of a world made up of two parts, mind and matter. This point of view we preserved throughout our scientific survey up to our criticism of the relation of body and mind. It was evident, however, from our preceding philosophical discussion that such a view was merely tentative, for it had already appeared that a dualistic view is incompatible with a theory of knowledge. From our criticism of the evolution of

mind and of the facts of the relation of body and mind, we also concluded that the materialistic and dualistic conceptions are both wholly inadequate. We have, therefore, strong grounds for accepting the provisional theory that reality is the organic unity of many minute minds as the only hypothesis which is philosophically and scientifically intelligible. If such a theory will describe the concrete behavior of nature as discovered by science, if it will reconcile conflicting scientific interpretations, if it is not inconsistent with any well-established observed fact, then additional reasons will be furnished for its acceptance. So let me try to show how the theory I advocate will, for me at least, accomplish the impossible. In this attempt I shall of course use philosophic as well as scientific tools, the most important philosophic tool being the assumption that an account of reality must not be self-contradictory and must be intelligible. I also assume that it must not be inconsistent with the observed facts which I have accepted as probable. These observed facts are of a very general nature and on most of them there is much scientific unanimity; so that our conclusions, though only very probable, will still have a considerable amount of probability.

In summing up the reasons for holding an idealistic theory of reality, I wish to reverse the procedure adopted in considering the scientific theory of evolution and to begin with mind; and, first of all, to remind the reader of the main reasons for rejecting a dualistic account of nature. It appears to me self-evident, as a presupposition for all science, that a phenomenon called thought exists, at least phenomenally, which attains truth. If this is not admitted, all science disappears. How can a mind attain truth? Following Royce and Berkeley, we saw that knowledge can exist only of thoughts in my individual mind. Such a position, at first sight, leads to the denial of the possibility of knowledge, to absolute scepticism. But this position is practically untenable, for it is impossible to live on such a

theory. It is also a very improbable theory, because science does give truth, as shown by the fact that scientific theories work. Scientific theories attain truth by assuming existences partly independent of my mind. Combining these two points of view, in order to make knowledge possible we must assume other minds that are at the same time a part of our minds and yet have their own individual existence. Such a theory makes knowledge of an external world possible, although no direct proof can be given for its existence. Moreover, such a theory escapes Mr. Bradley's criticism that all relational thought leads to a pernicious infinite regress; for a purpose having a meaning is a unity involving an infinite regress and is intelligible. Looking at the descriptions of science and the criticisms of the realist and at the very activity of thought itself, we are forced to regard reality as pluralistic in its appearances, as being composed of as many minute parts as science decrees are necessary. Such an atomic description is held to be probably a somewhat provisional view. The external material world is that part of my ideas which are found by experience to belong to you and to me and to the object. The laws of science are purposes which have become habits and are fixed. Such, I believe, is the only kind of hypothesis that will include all the observed facts we have recorded.

Instead of examining the various probable conclusions we have mentioned, it will be more advantageous to apply our conception to the theory of evolution as a whole. In this way a constructive exposition may be given, as well as a demonstration that these various points, and even some others, are conceivably included. It must, however, be remembered that the descriptions of reality given by physics, which in the main we accept, are conceived as figurative, as convenient, as a sort of scientific shorthand, but not as ultimate reality, for reality is ultimately a whole. It must also be remembered that the descriptions of

physics are incomplete, hence our description must necessarily be incomplete. Our account of evolution, then, will be figurative and also artificial and unreal, but less so on the whole, I think, than such a description in the ordinary orthodox term; of course it will be incomplete.

In the beginning there was unrest of mind, which wished to do something; but, when it tried, it found that it split itself up into an infinite number of little minds (vortices in the ether or what not) each of which was active, remembered a little, could choose a little. These little minds were active in different ways, but at first all their activity was at random. They were different and had different activities; for, as Dr. Henderson shows, an evolution could not occur unless the original elements had diverse properties which combined in diverse ways. Expressed in quantitative terms, these little minds bear the same relation to our complex minds, in respect to their mental powers, that the electrons bear to our bodies in respect to their physical powers and size. But, though diverse, the little minds had something in common: some liked to do one thing, some another, but they had this in common, that they wanted to combine, and some had mutual attraction. So presently they began to congregate into groups and form the primeval atoms and molecules. This did not satisfy them; and gradually the atoms took electrons—some more, some less—and arranged themselves into molecules having different patterns, thus forming the various chemical elements. But still the little minds were not at rest; they were still moving in all directions without plan, colliding with and jostling each other like what physics calls the molecules and masses of molecules of the various existing elements. Some of them, by their stronger purpose and activity and desire to attract others, and possibly but not probably through the greater knowledge they had acquired in the course of unlimited time,

were able to form loose associations. They gathered into nebulæ. Here all was still chaos, but the superior minds continually strove to do something worth while. They tried by every possible experiment to draw the chaotic mass together and make the unruly members conform to law. This of course they could do only by curtailing their activity (physically described as the cooling of the nebula). By the continuation of this process of curbing the unruly and actually eliminating some by resolving them into their constituent elements, a semblance of order was produced: the earth, its elements, its atmosphere, and its waters were evolved. But the bigger minds, the more active, were still not content; they wished more coördination, more freedom to develop. So, by trying all sorts of experiments, they finally discovered protoplasm, and found that through a combination of this sort a very much greater variety of reactions could be made, that greater power and satisfaction resulted, and that successful experiments could be preserved and transmitted to further generations. By continued experiments they found that combinations of individuals into communities gave still better results, and that, if they combined the stored wisdom of two individuals into one (by conjugation), the new individuals thus formed often exhibited greater power than their parents. And so the process went on until man was reached. What the future race will be no one knows; it is a matter of experiment.

Now, apart from the fantastic, unusual aspect of such a theory, see what it does. All nature is of the same fundamental character; no question as to the origin of life and of mind as the emergence of new qualities arises; they are simply more developed forms of the original stuff.

Throughout our examination of scientific theories we have noticed these three tendencies: to explain observed facts in materialistic terms; to explain them, in part at least, in teleological terms; to confess ignorance. This last attitude is of course

unassailable, provided it does not tacitly assume mechanism and materialism. Our theory, when it is once agreed that physical law is not *necessary* sequence or conditions of events, furnishes a means of combining all these points of view and retaining the value of each. For if body and mind are communities of monads, and if physical nature is the laws of the fixed behavior of monads, there is no known limit to the process of describing organic functions, such as metabolism, in terms of the relatively fixed behavior of elements. Possibly even life itself may in the future be so described. Such a theory is not destructive of the scientific method and puts no fixed limitations upon it. It is in accord with the contention of the vitalists that in organic nature, even if organisms can be described more and more completely in terms of physical chemistry, yet there is still something left over, the unity of the organism, the creative advance of nature, entelechy, whatever one chooses to call it. This element I call purpose. In the organic functions this creative element is at a minimum, and possibly everything there is what we call physico-chemical. But, inasmuch as we hold that the creative element is present in some degree even in the chemical elements, we must conclude that both materialism modified and vitalism reinterpreted contain truth; that the materialistic method must be pushed to its limit, but that the ultimate explanation is in non-materialistic terms. Such a theory preserves the reality of purpose in the world and gives some account, however imperfect, of how purpose works.

So far our description in terms of purpose is easy enough; but, in order that evolution could proceed under such terms, habits and advantageous ways of behaving must have been stored up and passed along to the offspring. This is true in any theory of evolution, at least in any theory of organic evolution, in the sense that experience must in some way be preserved if any evolution is possible. But we have seen that in the higher

animals such acquired traits are probably never inherited unless they actually bring about changes in the germ. Whether acquired characters ever do this or not is a question. Changes in the germ which are brought about by the germ itself are very likely the only ones that are stored up. A germ is a cell. Are we, then, to suppose that all changes in a cell, however caused, are transmitted? Are we to suppose that any habitual or continuous changes in the original unicellular organisms were preserved and inherited by the offspring? I do not know, for science has not told me; but it would seem probable that only changes initiated by the cell itself, "spontaneous variations," are inherited, that all adventitious changes are lost. What for science is such a "spontaneous" change in the germ? Again, I do not know. But we may perhaps say with Thomson that the germ-cell is always striving to do more, and that this striving gives rise to variations which are inherited and are controlled by natural selection, the worst, the most harmful, variations being weeded out. This would explain the fact that although we, the developed germ, are always striving, yet it is the original striving of the undeveloped germ which alone is hereditary.

May we continue this line of argument to the beginning of things and say that changes in the environment, which produce changes in unicellular organisms, are not inherited but that spontaneous variations of the organism are? No one knows. It is a question for science to decide. Either it must decide that long-continued action of the environment so changes the single cell that some of these changes are transmitted, with the result that acquired characters are inherited and the course of evolution described in terms of habits transmitted to offspring is made easier, as indeed any theory of evolution is made more intelligible: or else science must decide that only the spontaneous activity of the single cell is transmitted. If it does the latter, it puts itself in a difficult position, for it has got to define sponta-

neous activity. Of course the spontaneous activity of a cell is easily expressed in mental terms: the cell learns something that it does not forget; if it learns something that it does not forget, then it transmits this trait to its offspring, otherwise not. But how about the forms preceding the cell? Do they learn, remember, and transmit? If all is mental, there is no reason why they should not; in fact, it seems reasonable to suppose that they do. So, in terms of the present theory of heredity, we may say that probably only spontaneous variations of these preëxisting substances or bits of reality, when remembered, can be transmitted.

Is it necessary to push this theory of heredity to the activity of electrons in diverse and rapid motion? Such a notion, that electrons form habits and transmit them to their offspring, is too fantastic even for me. What happens could, nevertheless, be expressed in mental terms. There is no need of introducing heredity into such a description, but some power that gives rise to heredity is necessary.

On the accepted theory of evolution, the power of gradually acquiring new ways of reacting and of retaining them in the germ, either as due to a process in the germ or as a process of impression upon it, must have arisen. This power is expressed equally as well in terms of memory as in physical terms. As to how the power of transmitting variations came into being science at present gives no answer. Nor does science tell us whether it is necessary to suppose that pre-organic substances and electrons possessed the potentiality of such power. It would seem on the whole that they must have. But if electrons are interpreted as monads, with the beginnings of the power of memory, some inkling of the process is furnished. When memory becomes sufficiently developed, as in single cells, heredity arises. It is not necessary to conceive of the memory of electrons as self-conscious memory, as the remembering of specific events with definite dates in the past; nor is it necessary to conceive of it as

unconscious memory, for we are acquainted in ourselves with memory that is neither of these two things. When we try to recall a person's name which we have forgotten, we are conscious that the name is not Smith or Jones or Brown, and yet we are unable to tell what it is; but, if it does appear, it is immediately recognized as the name for which we were searching. It is this kind of not-self-conscious memory, in an infinitesimal degree, that primitive beings must be supposed to possess. Science may, to be sure, have to revise its whole theory of heredity; but that heredity is memory of the germ is not inconsistent with the present scientific formulation. In a word, science does not yet furnish us with a complete theory of heredity, variation, and their relation to environment. What it now holds can be stated either in material or in mental terms.

It may perhaps be objected that we have given no clear account of the activities of electrons, no description of their individual properties. This is true, but the lack is due to scientific ignorance. We have seen that no theory of cosmic evolution is generally accepted as proved; presumably the sole known law covering all evolutionary processes is the second law of thermodynamics. This law, it seems to me, merely states that reality tends to reach an equilibrium. But this can be stated in mental as well as in physical terms, — the equilibrium is the harmonious adjustment of minds that have reached perfection. In either case it is an ideal limit of the process of evolution. If science knew just what properties the original elements must have possessed to give rise to the world, then it could state the process of cosmic evolution. Until it does this, I cannot name these properties and so cannot state them in mental terms. But gravitation might be stated as a desire to approach other objects. If minds act in this fixed way, then such a description fulfils the requirements of physics. Chemical affinity was long ago translated by Goethe into mental terms, into *elective affini-*

ties. This translation could be made, I believe, for any properties that science ultimately says the elements must possess.

All this process of evolution is an active process and it is a creative process. What is activity? What is creation? Activity, I suppose, is motion; but motion is change. Change can be only with difficulty described by orthodox physics; change, moreover, is as much a mental as a physical phenomenon. Creation is still more difficult for mechanism to describe. A complex of like elements which contain all future possibilities is no more simple and no more complex than one which is described in precisely the same terms at another moment of time. Yet it is difficult to deny that in man a product of evolution is reached which is radically different from the original electrons, since man thinks the universe. It is only in terms of mind, as the creative activity of the imagination, that such a creative process can be understood. In the lowest forms, the electrons, such a process is blind striving; in man it is an ideal goal to be pursued.

This process of evolution about which everyone is so much concerned exhibits twists and turns and retrogressions which are difficult to describe in mechanical terms. Why should it not go on in a straight line? In mental terms, however, in terms of learning by experience, these aberrations are just what one would expect. That evolution can be expressed in such terms is of course one of M. Bergson's chief contributions to the philosophy of evolution.

Of the culminating result of evolution on this planet, man, — who is both body and mind, who apparently exhibits purposive activity, — and of the relations between purpose and law, our theory furnishes some sort of statable, intelligible account. Dualism and materialism furnish none. This subject we have sufficiently considered, with the exception of some remarks concerning the soul which I again wish to postpone.

In regard to the differences of opinion about elementary

organic functions our theory, as has been pointed out, provides an intelligible reconciliation, as indeed it does of the conflicting opinions as to the interpretation of the course of evolution. If all is mental and if some of the mental is fixed ways of acting, then if a human body is composed of such mental elements we should expect to find in its elementary functions fixed ways of behavior that are like those observed in the so-called physical world; we should expect also to find elementary manifestations of purpose that is not fully conscious of itself but that is in the nature of blind striving for a dimly perceived end. That both aspects are apparent we found to be the opinion of many scientists. Our theory would also explain why there is so marked a similarity between the organic and the inorganic processes that we have concluded they are identical in kind. Moreover, such a theory is not inconsistent with the observed fact that organisms seem to be cases of the conservation of energy in closed systems. For the body gets nourishment from the inorganic; this nourishment gives the basis for activity. If this activity is conceived as purpose, in so far as it can be measured it will still conform to the laws of activity observed elsewhere. By eating sugar I simply acquire mental energy through acquiring the mental energy of the electrons of the sugar. There is no reason for assuming that this energy of the sugar must be stated in material terms. Also this theory, when applied to the total course of evolution, explains why evolution should show at the same time purpose and mechanism; for reality is purpose becoming fixed in habit.[1]

When we face the larger question whether such an idealistic view of energy and activity and of the productive, creative advance of nature can be applied to the universe as a whole in such a way as to be consistent with the idea of the conservation of matter and energy and with the second law of thermodynamics,

[1] For a somewhat different account of organic evolution in terms of purpose, cf. McDougall, *Body and Mind*, pp. 376–379, and *Outline of Psychology*, pp. 448–449.

we meet grave difficulties. How can anything new be created, if all is fixed and determined? How can evolution continue if the energy of the world is being continually dissipated and transformed to less available forms? For, if quantity is finite and time infinite, all activity must eventually cease. Moreover, if past time is infinite, then on the assumption of a fixed quantity of matter and energy it is difficult to understand why evolution has not already ceased. On the other hand, if purpose is real, then its valuable fruits must be eternally preserved. The acts of men that are of use to the universe cannot conceivably perish. I deliberately use the word *conceivably* because I think that the presupposition underlying all science, all human endeavor, is just this, — some kind of immortality is necessary. This leads us to the most vexing question of all: How can the view of science which is most generally held, that the process of evolution is eventually to end, be reconciled with the necessity of thought that it shall not end?

I can give no answer to this question, but I should like to express my vague feeling in regard to it. I do not agree with Mr. Schiller that the seriousness of this problem is reduced by the consideration that our purposes, our duties, are chiefly concerned with what happens on the surface of the earth.[1] Purposes are really concerned with this earth only if they have some influence on eternity.

Mr. Hobhouse, however, thinks that if we find ourselves on a sinking ship, or if we are certain that a geological catastrophe will destroy all conscious existence, say, fifty years hence, it will still be our duty to die like men and meanwhile to do what is best to make life as good a thing as possible.[2] I fear that Mr. Hobhouse's instincts of an English gentleman have obscured his insight as a philosopher. No doubt in such a case it appeals to

[1] F. C. S. Schiller, *Studies in Humanism*, 1907, p. 412.

[2] L. T. Hobhouse, *The Rational Good*, New York, 1921, pp. [illegible]

our æsthetic sense to die like men; but suppose some poor soul insists that he is going to get drunk. How could you argue that it makes the slightest *real* difference whether he does so or not?

Although I cannot tell you just how we can influence eternity, I do not despair that a solution may eventually be found. The time consumed by the evolution of the human mind on this earth is but an instant in the cosmic time. Of this instant only a very small fraction has been applied to formulating this problem, much less in trying to solve it. So it would not seem that we have given the human mind a fair chance. Moreover, it appears that science at present offers a legitimate hope for a very long period of future human evolution, even on this earth. Therefore I hope for better suggestions toward the solution of this problem than I can offer, and I am not without hope that the problem may eventually be solved. I have, moreover, several very vague notions of the way in which it may be solved.

If human evolution could go on forever on the earth, and if the gradual acquisition of knowledge could be handed down by tradition, then the problem would conceivably be solved. I think there is little hope that evolution can continue forever on the earth, but it is possible that cosmic evolution may be such an infinite process. You will remember Chamberlin holds that science cannot at present affirm that such a theory is impossible. I should suppose that this would involve revision of the usually accepted ideas of conservation of matter and energy, of the second law of thermodynamics, and of the concepts of space and time. But Sir Oliver Lodge seems to meet with equanimity such revision in respect to matter, and the physical concepts of space and time are already undergoing change. Moreover, these concepts are among the most difficult for science or philosophy to describe, as is shown in the recent discussions of Whitehead, Broad, and Eddington. It is possible, then, that science may

conclude that cosmic evolution is an infinite process. But even this would not help us very much. How could our achievements here influence the cosmic process? The inevitable answer appears to be that we can influence such a process only if what we do here is preserved and handed on to the cosmic process which is actually occurring on some other sphere. But, so far as we know, our achievements are handed on by tradition and by biological heredity. If the scientific account is correct, transmission by any sort of heredity known to us is through the agency of protoplasm and must eventually cease on the earth. This mode of preserving our purposes is thus probably barred out. The other way in which we can preserve our achievement is by telling other people about them. Within the bounds of possibility but not of probability, by some process of telepathy or by some other unknown agency, we may be able in the future to communicate in a physical manner with other worlds and help their development. Such a solution appears to me to be fantastic.

It may be it will be found that the electrons, by going through the long process of learning how to combine into human minds, and especially into the best human minds, become modified; so that, when this solar system has been dispersed by collision into its ultimate electrons, the new world gradually evolved will be better for having been through a process of evolution on this earth. But this solution is likewise incredible.

It may be that minds are in an organic relation with all the rest of the universe, so that what I think modifies in an infinitesimal degree all other minds; and that this process is so refined that it escapes our powers of observation and yet is real. Or it may be that the result of evolution is to be an equilibrium of two huge bodies moving through space, and that these two bodies will furnish conditions for organisms which could be physically described as attenuated new forms of protoplasmic substance

evolved through untold ages. Perhaps this substance will be merely forms of the ether of space, needing no atmosphere, no nourishment, something like Sir Oliver Lodge's spirits. Such a world could be conceived as not only in physical but also in spiritual equilibrium, where all problems are solved, "where the wicked cease from troubling and the weary are at rest." Our endeavor on this earth would be preserved by the subtle influence of our minds on the spiritual beings that inhabit other spheres. Such a solution likewise seems fantastic,[1] but possibly in a somewhat less degree.

Now, it is the difficulty of formulating any physical theory of immortality, as I have been trying to do, that has led people to posit an immaterial soul, having no connection with protoplasm or any material substance, which is immortal; or to posit the existence of a God who knows what we do and is helped by our achievements in his future evolution of other worlds; or both. The hypothesis of the individual immortal soul does not appeal to me. All we know about human souls is that they exist in conjunction with protoplasm, and this is true whether protoplasm is conceived in materialistic or in idealistic terms. So far as we have any conclusive evidence, when this substance resolves into its constituent elements, the soul resolves too.

To me, on the whole, the assumption of a higher consciousness, perhaps not personal in our sense of the word but one that is striving to better reality, that knows what goes on in our little minds as we know to some extent what goes on in the mind of a dog although the dog only dimly comprehends us, a consciousness that is limited in the sense that it has not learned how to do what it wants to do, — is not an absolute, — a consciousness that is aided or hindered by our human efforts, is the best present solution of the mystery. Such a view preserves the ethical

[1] Cf W. K. Clifford, *Lectures and Essays*, 1879, i, 228–253 ("The Unseen Universe").

value of human purpose, for everything we do either helps or hinders God.

But, although such an idea in the abstract seems easy of comprehension, just as the theory of evolution seems almost self-evident, yet when we try to give concrete form to such a conception we again meet difficulties. All thought actually known to us has objective form; mind has a body, which is that part of mind that is common to several individuals. It is possible, however, to conceive of thought as solipsistic. Here no body is necessary. If we conceive of God as a being who includes all individuals and leads a solipsistic life, our existence would be merely thoughts in his mind, and for us the sole reality would be his existence. He would be an absolute, and all human individuality would disappear. The reality of our purposes would also vanish. This concept we have seen reason for rejecting. If we conceive of God as a higher individual living in a community with us, then when known and in so far as known God would have some objective existence, would appear as some sort of body. What conception can we form of the body of God, of his objective existence? It is impossible for me to regard it, as Fechner did, as the unified sum of the physical activities of the earth or of the universe, for such activities do not, so far as science, philosophy, or common sense teach us, have consciousness as the unity of their activities: apparently our earth is not self-conscious. Consciousness is the unity of a certain combination of elements, of monads, which we call protoplasm. So, to conceive of God as existing as the most perfect spirit, who lives in a community of lesser spirits, we are driven to think of him in his objective form as some combination of monads, as some substance. This leads us back to some vague notion like Sir Oliver Lodge's, that the objective existence of spirits is a peculiar, attenuated form of matter. Of such matter we have no knowledge at present.

It is, however, possible to form some conception, however

vague, of the objective existence of such a superior being. Our theory of the human mind is that it is a whole which is figuratively described as composed of parts; these parts are the minds of the cells of my body. God is the unity of the minds of all the universe, so that when I regard nature as a whole I am seeing God. The process of nature tends ever to increase in knowledge and adjustment, to reach an equilibrium. The objective aspect of this process is described by physics as increasing entropy; so that the physical picture of the result of evolution is perhaps two huge spheres balanced in space, of an equal temperature of, I suppose, absolute zero. I do not know that the temperature must be as described, but I should suppose this would be the result. Of course no life as we know it could exist under such conditions. If this is the result of evolution, we must suppose that consciousness, thought, still exists; otherwise the whole evolutionary process is futile. Mind stirred, had a dream, and went back to untroubled sleep. Such a view is held by the Buddhists. To me it is not satisfactory. Nor is it possible for me to think that whatever consciousness is present at this end of evolution is the unity of the material globes, an earth-consciousness. If the physical result is what we have just suggested, I must believe that by this long process mind has learned to exist under different conditions from those we know at present.

But such a view seems too unreal; I do not believe that is the answer. What I think is this: the concepts of science, space, time, matter, the conservation of matter and energy, the second law of thermodynamics, are not *necessary* truths It is probable that as time goes on they will be revised, so that the process of physical evolution will be conceived as a process which never reaches the equilibrium of absolute zero, with the result that life in some form will always be possible. It would then be possible to conceive of God as made up of finite minds but as more than their mere sum, just as my mind is more than the mere sum of

its elements.[1] The process would be eternal and the equilibrium would be an active, not a dead, one. The worth of human endeavor would be preserved. Such a solution implies that beings, or a being, now exists independent of the future of this earth who has the capacity of storing the results of human endeavor That such a being should have this power and not apparently possess the means of communication with us seems extraordinary. There is no proof that we get help from supernatural agencies, unless indeed the creative power of thought implies such a reservoir as James suggested.

So, no solution of the problem of immortality is wholly satisfactory. But I have confidence, faith if you like, that a solution will eventually be found and that it will reinterpret evolution as an infinite process in which our human endeavor counts. In this faith I find the basis of all religion.

I do not, however, think that my opinion about the probability of the revision of the scientific account of evolution is *mere* faith. We have seen that orthodox science is wholly incapable of furnishing an account of nature (including in nature, of course, man), not because science has as yet failed to describe cosmic evolution, has not yet learned the origin of life, not yet completely solved all its problems, but because the fundamental concepts of orthodox science — necessary law, and a reality which exists independently of *all* mind — are not true. Necessary law is not proved and is not essential to science, it is a dogmatic prejudice; a reality existing independent of all mind is irrational, and is not necessary to scientific truth. For this reason I believe all thinking persons have the duty to refuse to accept a description of evolution which results in annihilation, and the duty to believe that a better statement will eventually be found.

[1] Some of the difficulties of such a conception are indicated in Ralph Barton Perry's "Is Society a Person?" in *Journal of Philosophy*, xxi, No 4 (Feb. 14, 1924).

There are two more almost as intricate and perplexing problems about human conduct which must be mentioned. Thomas à Kempis believed that "thou shouldst be inwardly free and thoroughly master of thyself; and that all things be under thee and not thou under them"; also that a virtuous life maketh a man dear to God. That ethical freedom and an ethical ideal of conduct are necessary to a theory of character interpreted in the way we have suggested goes without saying. Let us, then, face the problem of determinism and indeterminism.

You will remember Dr. Watson says that human conduct must be determined by something and that the aim of psychology is to determine what this something is. With this I agree. I have written many pages to try to convince you that this something which determines human conduct is not primarily outward forces but is the purposive response of the individual to these forces. In this way it might easily be admitted that man is, in part at least, inwardly determined and in that sense free. But this does not, to my mind, solve the problem. Man's character, what determines his response, is, in so far as it is not due to outward forces, determined by his heredity. So even on our idealistic theory man's conduct is determined by something. How, then, can he be said to be ethically free?

I believe that freedom consists solely in the fact that sometimes we are determined by a special inward process, by that of reasoning. Usually we are inwardly determined by merely our lower inherited instincts or urges; but among these inherited powers is the power of weighing in a rational way all the opposing forces and reaching a decision on rational grounds. Such a decision may be erroneous; this is not the fault of the *process* but of the finitude of man. All men, perhaps some animals, have inherited this power by an infinite consummation of inherited traits. How much of it you possess, how much I possess, no one

knows. It seems probable that it cannot be stated in quantitative terms. One of the conditions of the best fruition of this power, like that of all human activity, is that it should be continually exercised. Moreover, this rational activity is not a fixed quantity in the universe. By the use of its most developed form, the rational constructive imagination, new reality is produced. Where this creative power comes from I do not know. We have already spoken of it. Without it neither ethical freedom nor the creative advance of nature is possible. So we are inwardly and ethically free when we are determined by this creative power, which we all possess in some degree and which we can increase.[1]

And this gives us some insight into what we may call a virtuous life. Let us take an example. Smith is born into the world with a happy combination of instincts, so that he leads the life of a saint on earth. He is determined by his heredity in such a way that he does not sin. If he reflects on his conduct and finds that it is rationally good and that opposed ways of acting are morally bad, he is a virtuous man, otherwise a mere machine. His morality depends on whether he rationally approves of his conduct or not. He may be determined by outward compulsion and yet at the same time be ethically free because he assents. If he just lives blindly, he is a fortunate individual but not a self-conscious ethical agent. A wholly evil man would be determined by wholly evil heredity, with no spark of rational rebellion against his conduct; such an unfortunate must be eliminated. But most of us have evil mixed with the good in our inheritance. When we follow our impulses, good or bad, we are determined by our physical heredity; we are inwardly determined but not inwardly free. When we exercise our inherited powers of reason-

[1] For an interesting discussion of this subject, see George Herbert Palmer, *The Problem of Freedom*, 1911.

ing to curb some activities and support others because we see such conduct is rational, then in so far as we succeed we are inwardly free. Only in some such sense have freedom and a virtuous life any meaning for me. This power for rational conduct is not fixed but may be augmented.

The other question raised by St. Thomas is that of the possibility of forming a rational ideal of conduct, — no easy task, as the history of ethics will show. It seems to me that a rational ideal can be founded only on those discoveries of science which help us to live and to make full use of all our powers. Ethics, for me, would then rest first of all on the laws of hygiene. One must eat with moderation but enjoyment; one must exercise, but with discretion. Many of such elemental facts, that lead to the greater happiness and usefulness of the individual and of society, are known but are seldom practised. When it is asked what science can tell us about rules for more complicated conduct, it becomes more difficult to reply. The reason is that the science of man has just begun. For example, we do not know what conditions of social environment are best for man as an individual and as a member of society. Perhaps we may agree that we must tell the truth and have regard for the rights of others. I should think that a large number of generally accepted rules for scientific conduct could thus be formulated. But the obligation to tell the truth is not generally recognized in social practice, even if it is held to be a fundamental in social theory. When one comes to the relations between the sexes, even the elements of hygiene are often disregarded, to say nothing of higher obligations.

But I do not intend, nor am I qualified, to write a system of ethics. To my mind such a system must be founded on what science discovers little by little to be best for the usefulness of the individual as a member of society. Such usefulness includes,

of course, the exercise of the highest intellectual powers and is, I believe, accompanied by the greatest satisfaction to the individual. The highest ideal of conduct would, then, contain a knowledge of what science teaches and a rational reflection on such knowledge, which give rise to the best discoverable practical ideal for making the individual more nearly perfect and, through the individual, society. The carrying out of this ideal would give the individual the greatest possible happiness and would result in the greatest possible happiness to society. The ideal goal would be a state of society in which all individuals had attained perfect knowledge of how to act and in which all individuals always acted in the light of this knowledge, with the result that all individuals and society as a whole would be perfectly happy. A state of complete equilibrium would be attained and evolution would cease.

No comment, I think, is required as to the bearing of such a theory on a philosophy of character. It is true that we have given no account of the empirical aspects of character; we have not shown in detail how fine character, or any character, is developed. Such, I conceive, is the task of the purposive psychology of the future, a task only just begun. It is my ambition to contribute to such a purposive psychology. At present all that has been accomplished, if indeed anything has, is to furnish some intelligible basis on which such a psychology may be reared. We have attempted to show that purpose is the active agent in reality. But I believe we can see a little more clearly that Emerson was right in holding that the individual is an encloser of the infinite, that individuals exist in various grades, that they influence one another. St. Thomas was right in holding that we must and can be inwardly and ethically free. Carlyle was right in saying that we are soldiers fighting in the dark, but wrong in holding that no ray of light penetrates the dark-

ness. But Carlyle was emphatically right in saying that, given a world of knaves, it is impossible to produce an honesty from their united action; and Carlyle was in a very concrete and real sense right when he expressed his philosophy in the words,

> "My inheritance how wide and fair!
> Time is my fair seed-field, of Time I'm heir."

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